Amphenol Aerospace

CF-020400-69

Thermal Analysis

Oct 05, 2021

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Electronic Cooling Solutions Inc.

Objectives

1. To determine that the critical components on the CF-020400-69 board are within their thermal limits for the following cases:

   a) **23°C at sea level** (Initial assessment)

   b) **-40°C at sea level**

   c) **85°C at sea level**

   At 2 different power levels:

   a) **Predicted** – Total Power of 302.7 W

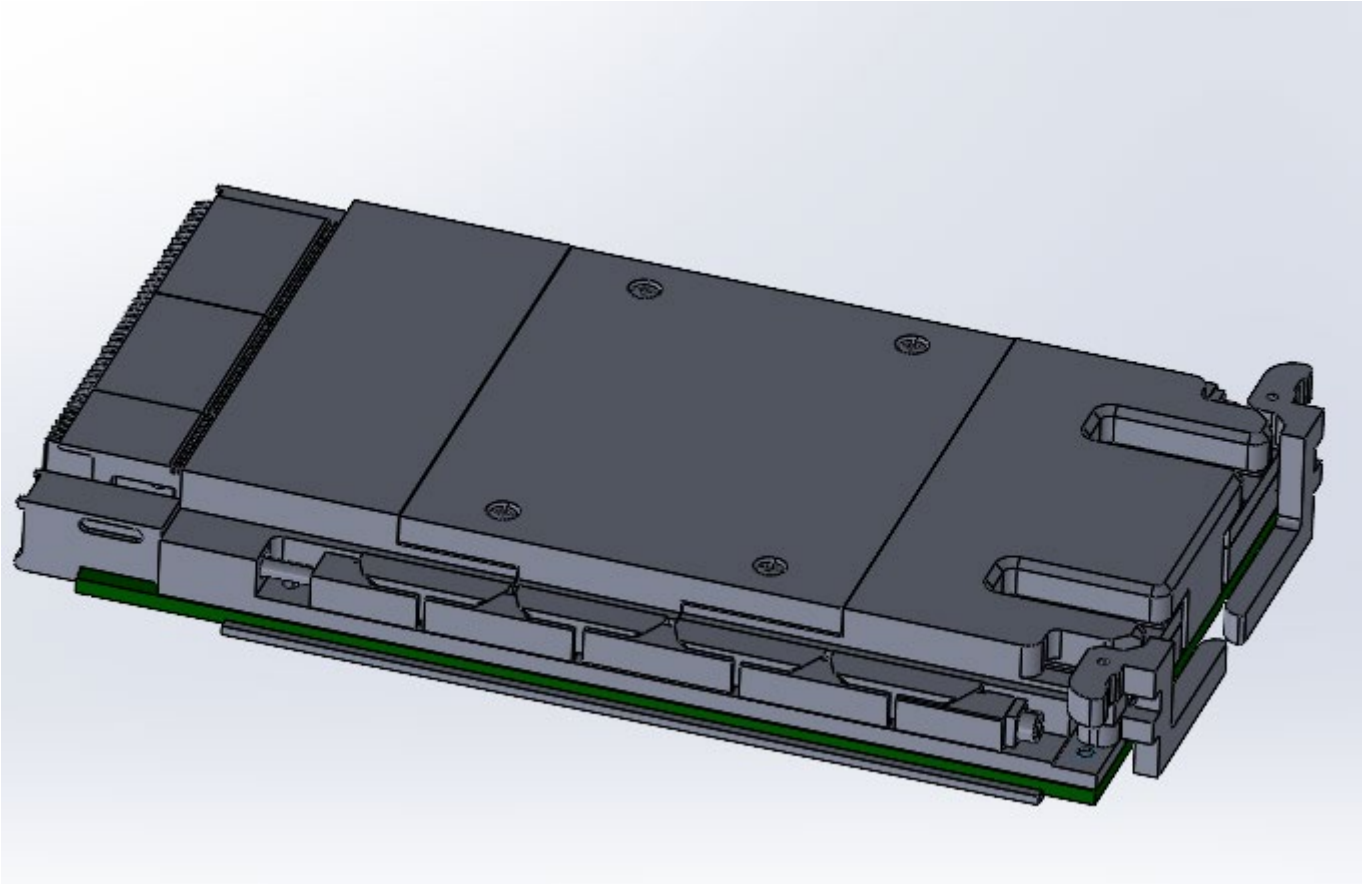
   b) **Worst Case** – Total Power of 386.2 W

Approach

1. This analysis was done using FloTHERM XT V2021.1 CFD software.
2. The updated thermal model was created from the cf-020400-069m_asm file provided for thermal analysis.
3. The Falcon & PCB components were obtained from the PDML files provided.
4. It was assumed that no neighboring devices were producing or sinking heat.
5. The rear cover was assigned Al 6063 T5 as the material. Copper Plate over the Falcon with the rest of the housing as Al 6063 T5 was used as a second iteration to reduce temperatures further.
6. Two different thickness thermal gap pads have been used for the components : 0.040” & 1.00” , both of which have a thermal conductivity of 17.8 W/m-K.
7. Graphite pad attached to the Falcon top has a thermal conductivity of 20.0 W/mK in the Z axis and 1000 W/mK in the X-Y axes.
8. The critical components were modeled as 2-resistor networks with thermal resistance values found on the “Parts Thermal Characteristics.doc”.

Thermal Model Setup

Thermal Model Setup – Overview



Enclosure Material – Copper as Plate over Falcon & Al6063 T5 as Rest of Housing & Rear Cover.

Thermal Data

CF-020400-54	Predicted			Worst Case			Thermal Resistance (ºC/W)/Model	
Component	Qty	Per Component	Total	Qty	Per Component	Total	R_{JB}	R_{JC}
Falcon	1	259.8	259.8	1	324.8	324.8	0.95	0.022
LTM4700 Core_VDD	2	8.6	17.2	2	10.7	21.4	1.75	3.1
LTM4700 GOP_VDD	1	6.8	6.8	1	8.6	8.6	1.75	3.1
LEAP	2	4.0	8	2	7.9	15.8		
CPU	1	5.1	5.1	1	7.8	7.8		
LTM4700 PLL_AVDD_VDDA	1	3.0	3	1	3.7	3.7	1.75	3.1
LTM4650 VDDH	1	1.3	1.3	1	1.7	1.7	1.5	3.7
ISL8201M	1	0.5	0.5	1	0.9	0.9	0.8	2
MAXM17515 CPU_CORE_1V08	1	0.5	0.5	1	0.7	0.7	1.5	6
LT1963 CPU_1V8	1	0.2	0.2	1	0.3	0.3		
TPS51206 CPU_V_VTT	1	0.1	0.1	1	0.2	0.2		
MAXM17515 CPU_3V3	1	0.1	0.1	1	0.2	0.2	1.5	6
MAXM17515 CPU_VDDM1V5	1	0.1	0.1	1	0.1	0.1	1.5	6
		Total	**302.7**		**Total**	**386.2**		

Note: Thermal resistances from junction to case (R_{JC}) and from junction to board (R_{JB}) and thermal limits were taken from “Parts Thermal Characteristics”.

Note: For this set of simulations, the predicted power values were used.

Thermal Analysis

ElectronicCooling Solutions inc

Results Summary – Comparison between Worst Case Power Temperature Cases

Design 2 – Copper Plate over Falcon, Al 6063 T5 Rest of Housing & Al 6063 T5 Rear Cover

Parameters				Sim 5			Sim 3			Sim 7			Sim 7			Sim 7		
Power Scenario				Worst Case			Worst Case			Worst Case			Worst Case			Worst Case		
Cooling Rail Temperature °C				-40			23			85			56			50.6		
Ambient Temp., °C				-40			23			85			85			85		
Elevation, ft				0			0			0			0			0		
RESULTS																		
Component	Min. Limit, °C	Max. Limit, °C	Limit Type	Power, W	Result, °C	Margin from Negative Temp, °C	Power, W	Result, °C	Margin, °C	Power, W	Result, °C	Margin, °C	Power, W	Result, °C	Margin, °C	Power, W	Result, °C	Margin, °C
Falcon	-40	110	junction	324.8	-4.5	35.5	324.8	58.5	51.5	324.8	120.6	-10.6	324.8	91.7	18.3	324.8	86.3	23.7
LTM4700 Core_VDD (max)	-40	125	Junction	10.7	2.9	42.9	10.7	65.9	59.1	10.7	127.9	-2.9	10.7	99.1	25.9	10.7	93.6	31.4
LTM4700 GOP_VDD	-40	125	junction	8.6	-6.5	33.5	8.6	56.4	68.6	8.6	118.4	6.6	8.6	89.5	35.5	8.6	84.1	40.9
LEAP (max)	0	70	case	7.9	-21.1	-21.1	7.9	42.2	27.8	7.9	104.2	-34.2	7.9	75.4	-5.4	7.9	70.1	-0.1
CPU	-40	115	case	7.8	-20.8	19.2	7.8	42.2	72.8	7.8	104.1	10.9	7.8	75.4	39.6	7.8	70.1	54.9
LTM4700 PLL_AVDD_VDDA	-40	125	junction	3.7	-19.3	20.7	3.7	43.6	81.4	3.7	105.6	19.4	3.7	76.8	48.2	3.7	71.4	53.6
LTM4650 VDDH	-40	125	junction	1.7	-18.7	21.3	1.7	44.3	80.7	1.7	106.2	18.8	1.7	77.5	47.5	1.7	72.1	52.9
ISL8201M	-55	125	junction	0.9	-19.8	35.2	0.9	43.1	81.9	0.9	105.1	19.9	0.9	76.3	48.7	0.9	70.9	54.1
MAXM17515 CPU_CORE_1V08	-40	125	junction	0.7	-12.7	27.3	0.7	51.2	73.8	0.7	112.0	13.0	0.7	83.5	41.5	0.7	78.2	46.8
LT1963 CPU_1V8	-40	125	junction	0.3	-23.6	26.4	0.3	39.3	85.7	0.3	101.3	23.7	0.3	72.5	52.5	0.3	67.2	57.8
MAXM17515 CPU_3V3	-40	125	junction	0.2	-21.4	18.6	0.2	41.5	83.5	0.2	103.3	21.7	0.2	74.8	50.2	0.2	69.5	55.5
MAXM17515 CPU_VDDM1V5	-40	125	junction	0.1	-26.2	13.8	0.1	36.7	88.3	0.1	98.6	26.4	0.1	69.9	55.1	0.1	64.6	60.4

Results Summary – Comparison between Predicted Power Temperature Cases

Design 2 – Copper Plate over Falcon, Al 6063 T5 Rest of Housing & Al 6063 T5 Rear Cover

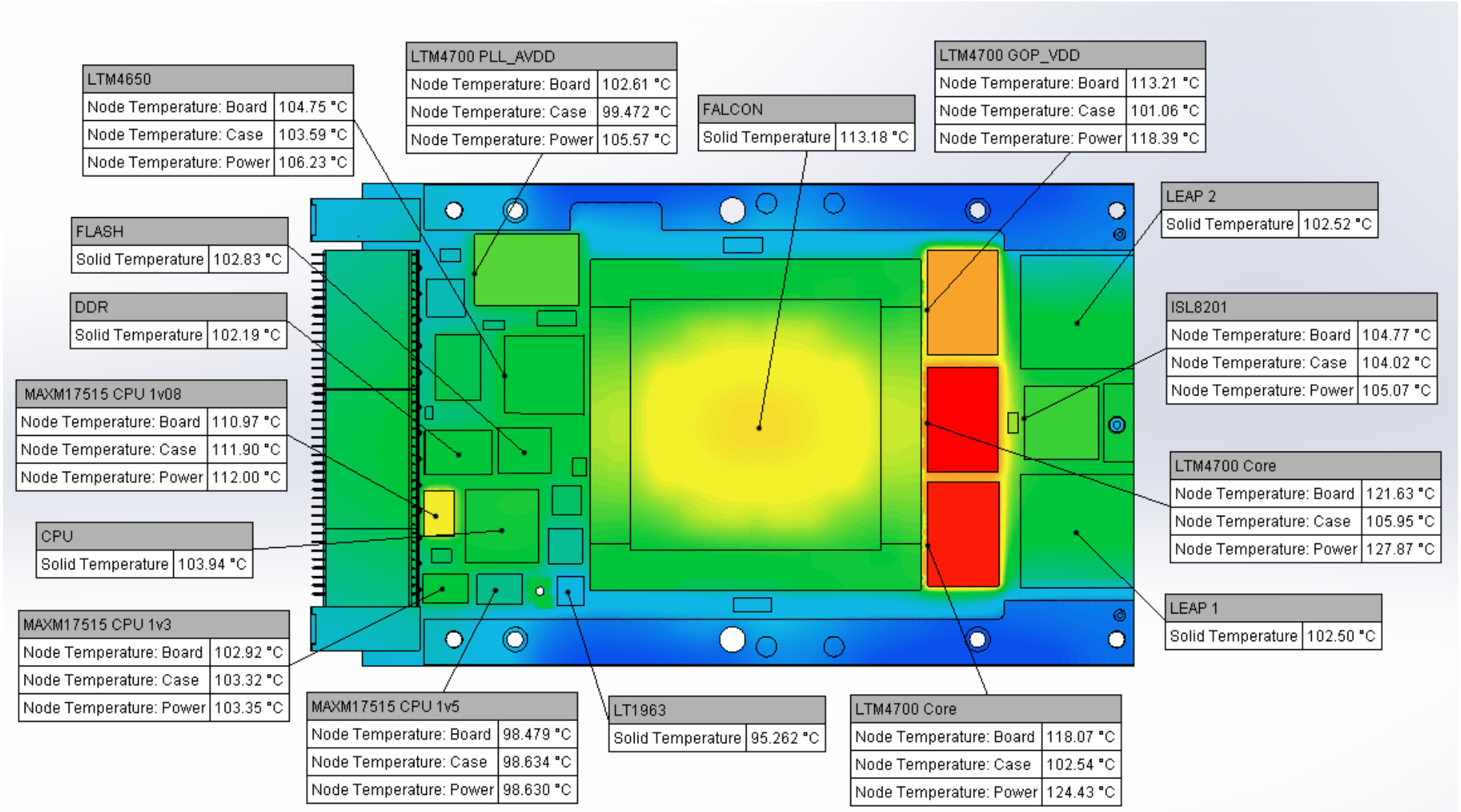
Parameters				Sim 6			Sim 4			Sim 8		
Power Scenario				Predicted			Predicted			Predicted		
Cooling Rail Temperature °C				-40			23			85		
Ambient Temp., °C				-40			23			85		
Elevation, ft				0			0			0		
RESULTS												
Component	Min. Limit, °C	Max. Limit, °C	Limit Type	Power, W	Result, °C	Margin from Negative Temp, °C	Power, W	Result, °C	Margin, °C	Power, W	Result, °C	Margin, °C
Falcon	-40	110	junction	259.8	-11.9	28.1	259.8	51.2	58.8	259.8	113.0	-3.0
LTM4700 Core_VDD (max)	-40	125	Junction	8.6	-6.1	33.9	8.6	56.9	68.1	8.6	118.4	6.6
LTM4700 GOP_VDD	-40	125	junction	6.8	-13.8	26.2	6.8	49.2	75.8	6.8	110.9	14.1
LEAP (max)	0	70	case	4.0	-25.9	-25.9	4.0	37.1	32.9	4.0	98.9	-28.9
CPU	-40	115	case	5.1	-25.3	14.7	5.1	37.7	77.3	5.1	99.3	15.7
LTM4700 PLL_AVDD_VDDA	-40	125	junction	3.0	-23.5	16.5	3.0	39.4	85.6	3.0	100.9	24.1
LTM4650 VDDH	-40	125	junction	1.3	-23.3	16.7	1.3	39.7	85.3	1.3	101.3	23.7
ISL8201M	-55	125	junction	0.5	-25.2	29.8	0.5	37.8	87.2	0.5	99.6	25.4
MAXM17515 CPU_CORE_1V08	-40	125	junction	0.5	-19.7	20.3	0.5	43.2	81.8	0.5	103.1	21.9
LT1963 CPU_1V8	-40	125	junction	0.2	-25.8	14.2	0.2	37.1	87.9	0.2	97.6	27.4
MAXM17515 CPU_3V3	-40	125	junction	0.1	-28.4	11.6	0.1	34.5	90.5	0.1	95.9	29.1
MAXM17515 CPU_VDDM1V5	-40	125	junction	0.1	-29.1	10.9	0.1	33.9	91.1	0.1	95.7	29.3

Worst Case Power Results

85 C Ambient, Vertical, 85C Cooling Rails
Copper Plate over Falcon, Al 6063 T5
Rest of Housing & Al 6063 T5 Rear Cover
Worst Case Power

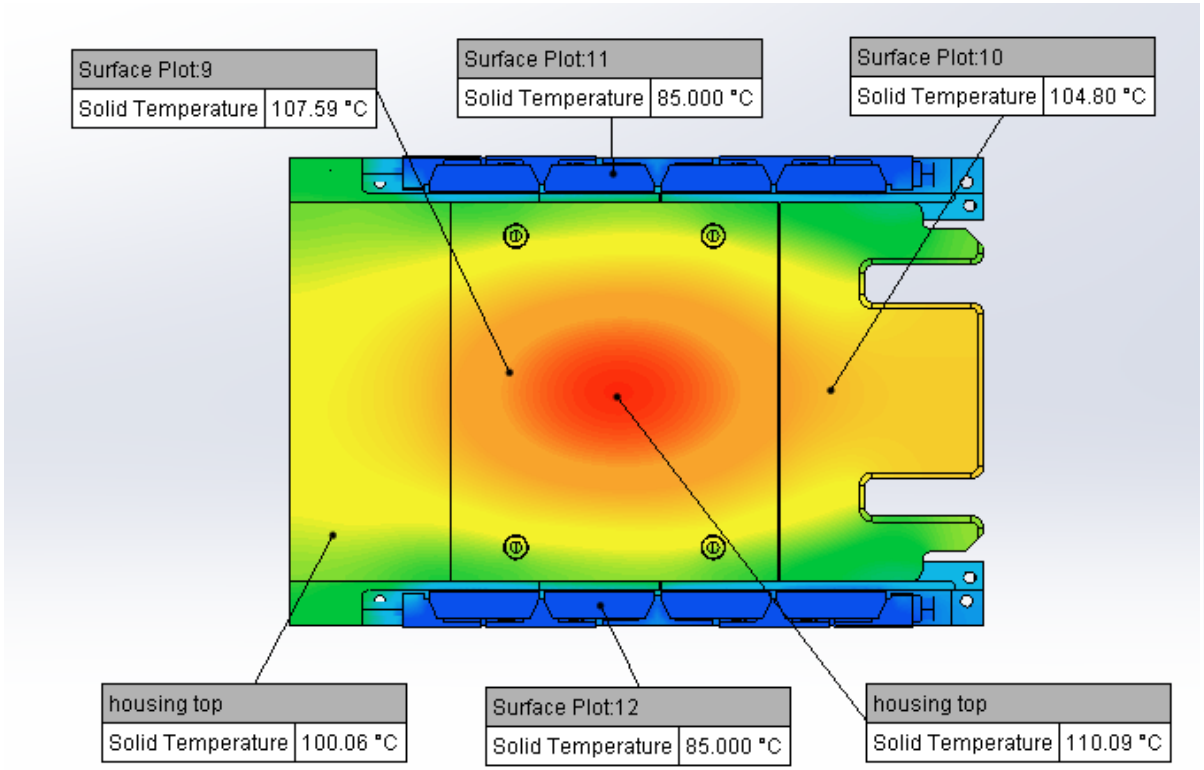
Components Temperature Plot

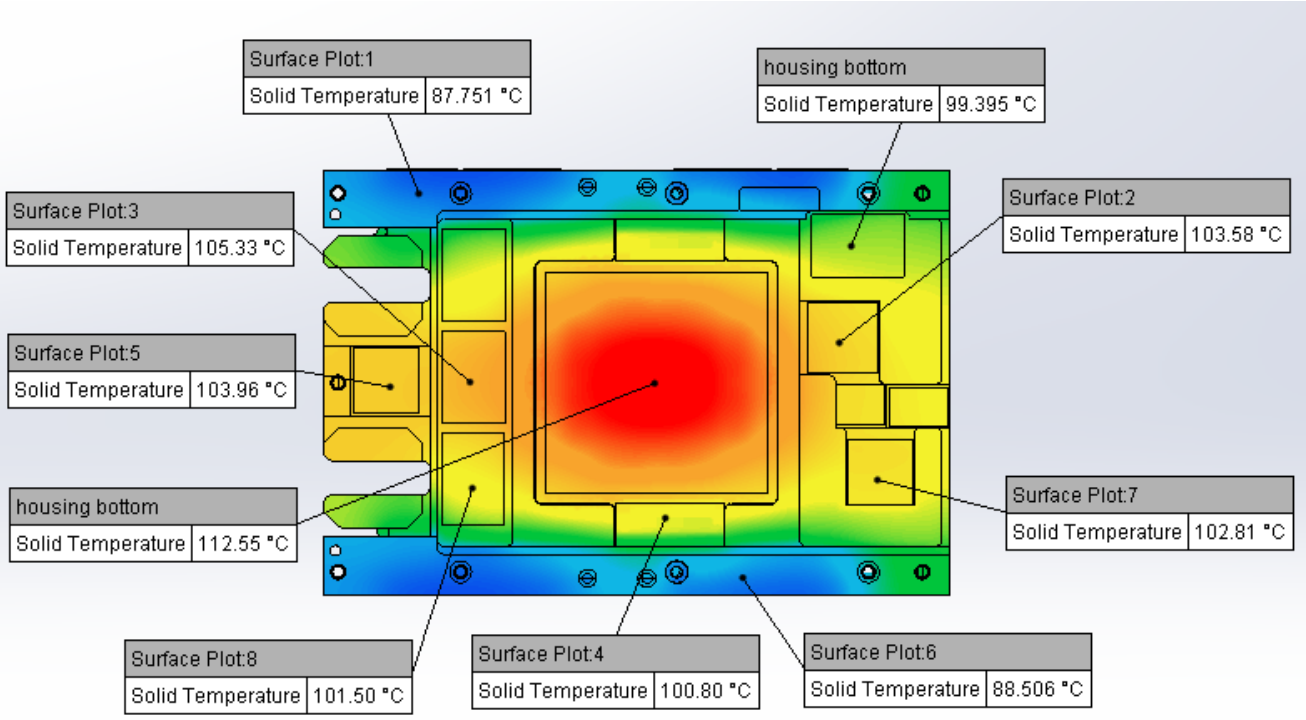
85°C , sea level

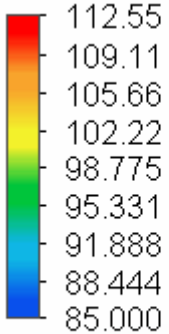


Housing Surface Temperature Plot

85°C , sea level





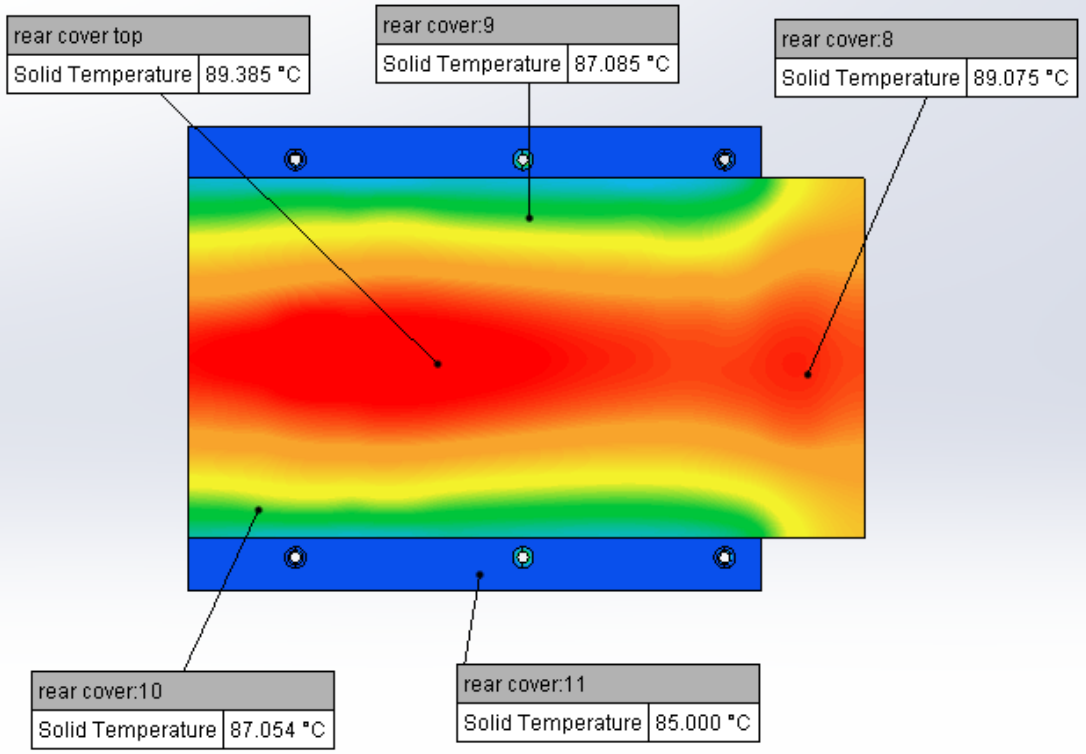


Top Side

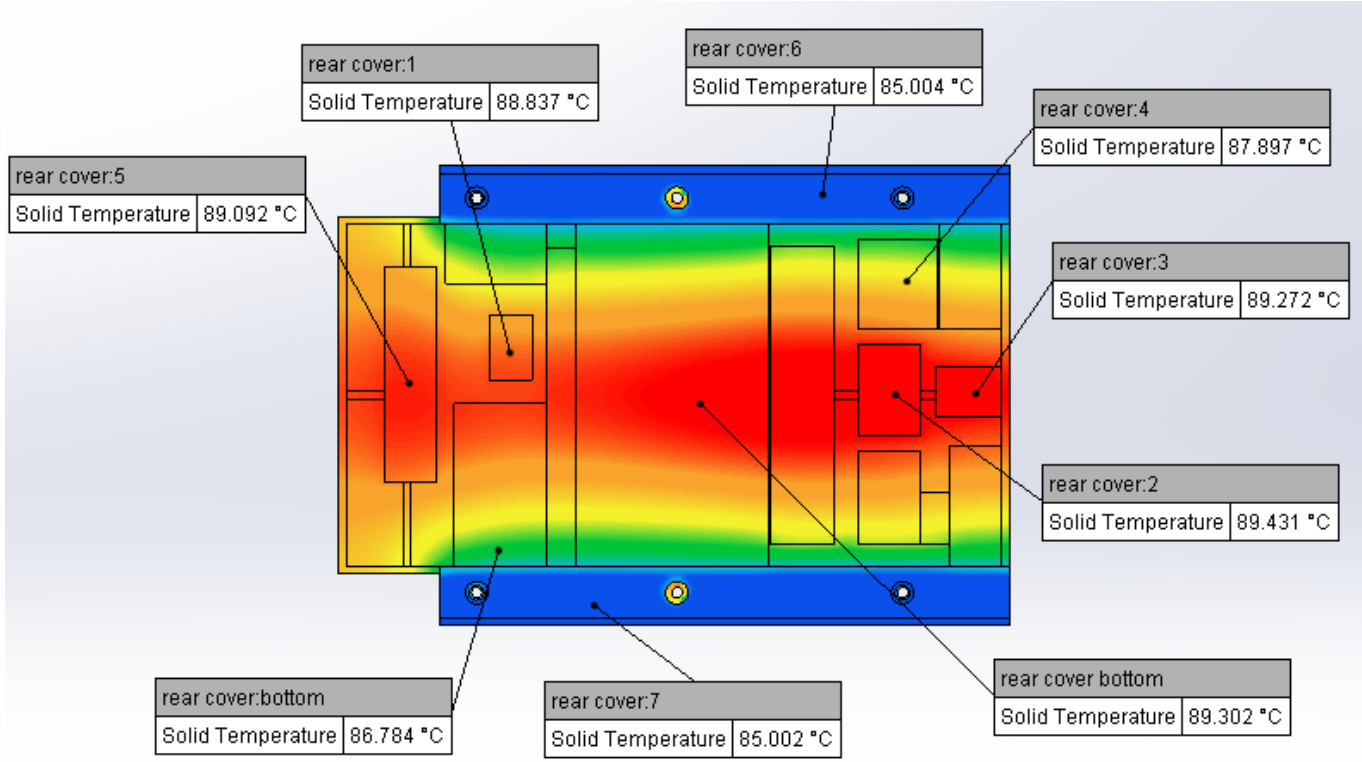
Bottom Side

Rear Cover Temperature Plot

85°C , sea level



Top Side



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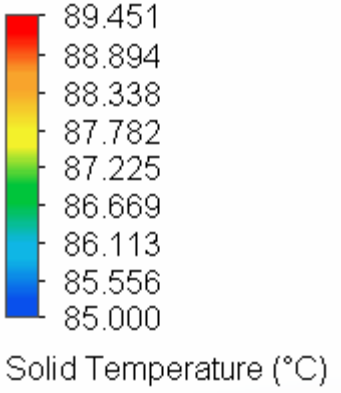
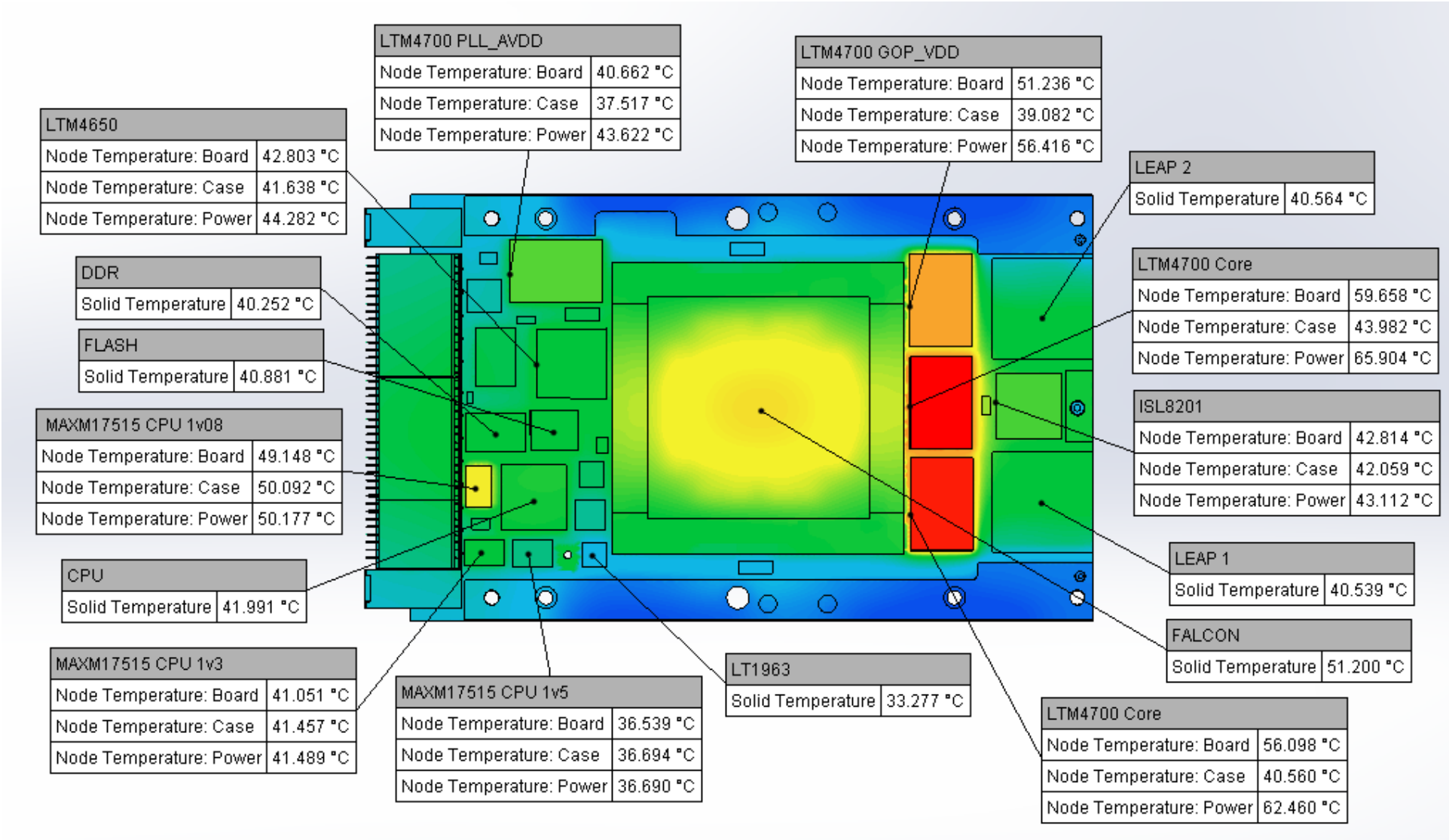


23 C Ambient, Vertical, 23C Cooling Rails
Copper Plate over Falcon, Al 6063 T5
Rest of Housing & Al 6063 T5 Rear Cover
Worst Case Power

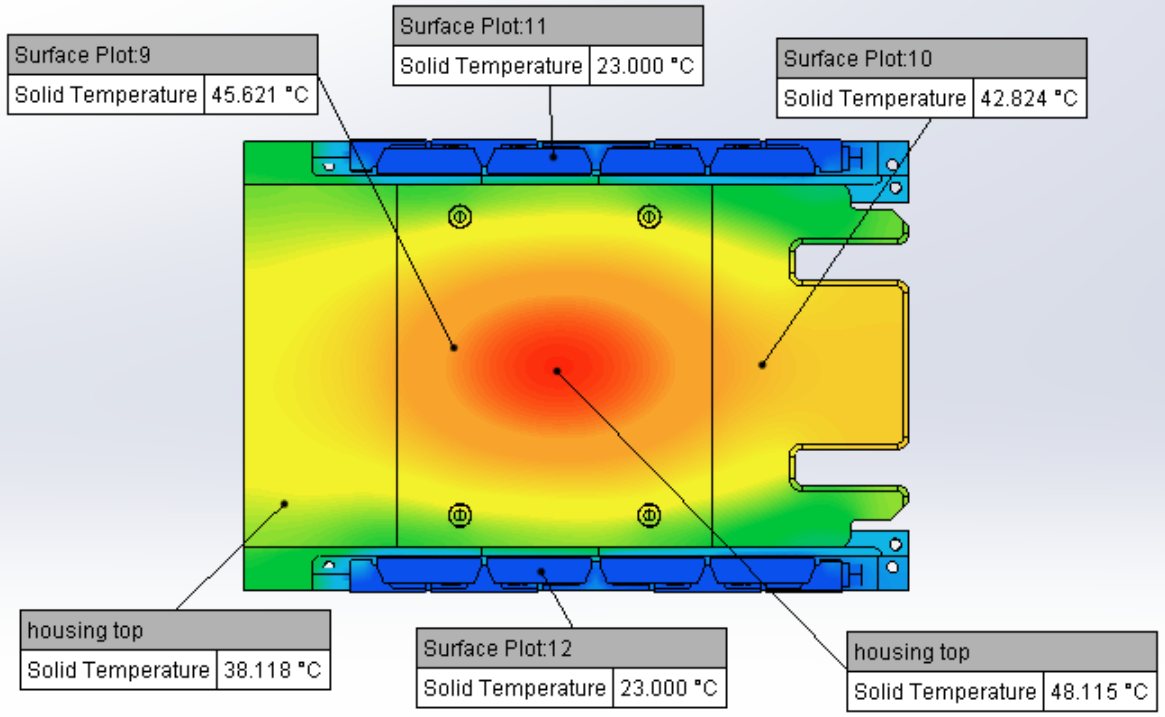
Components Temperature Plot

23°C , sea level

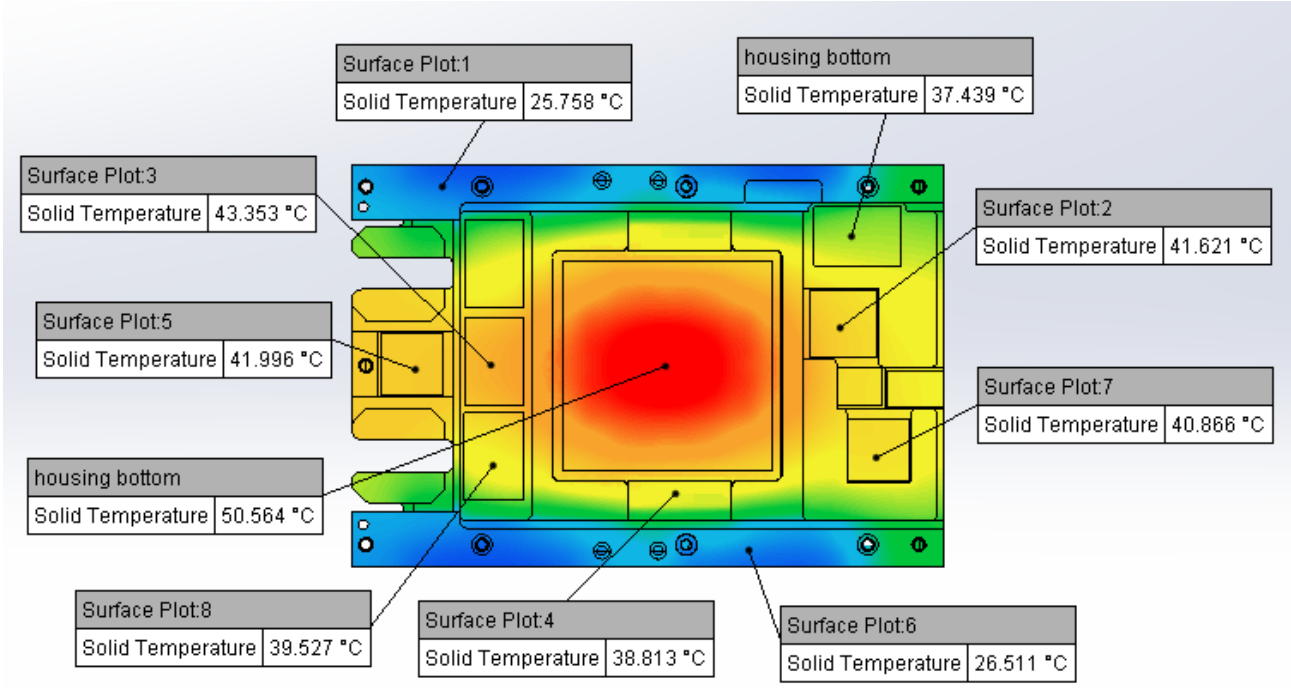


Housing Surface Temperature Plot

23°C , sea level



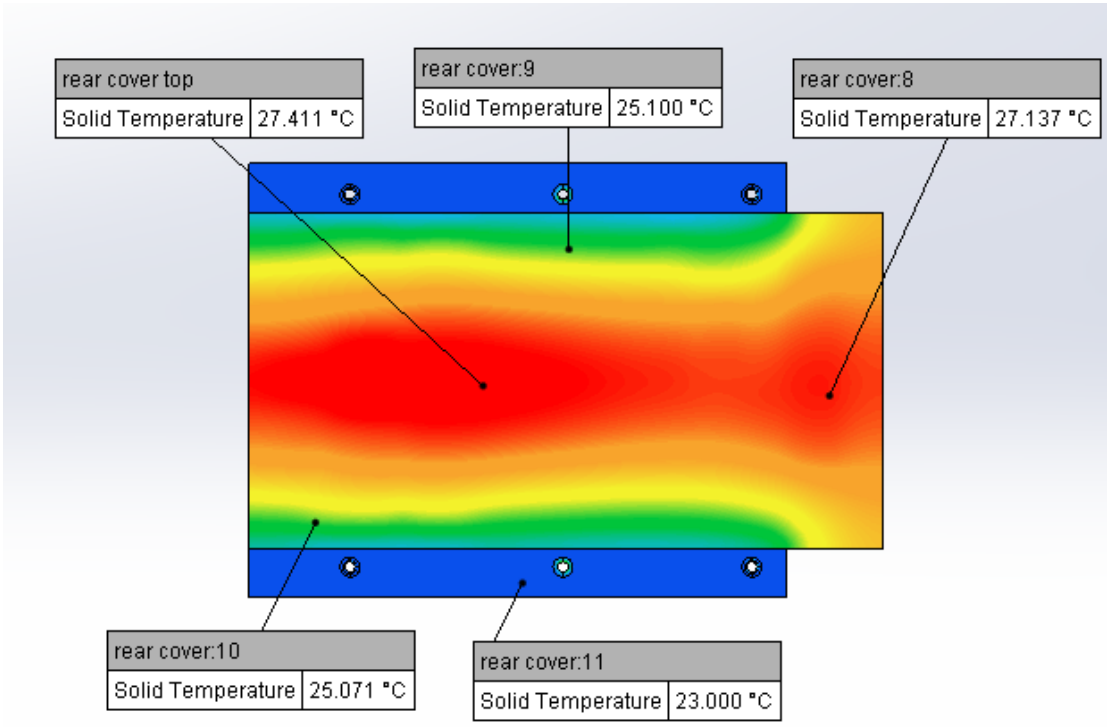
Top Side



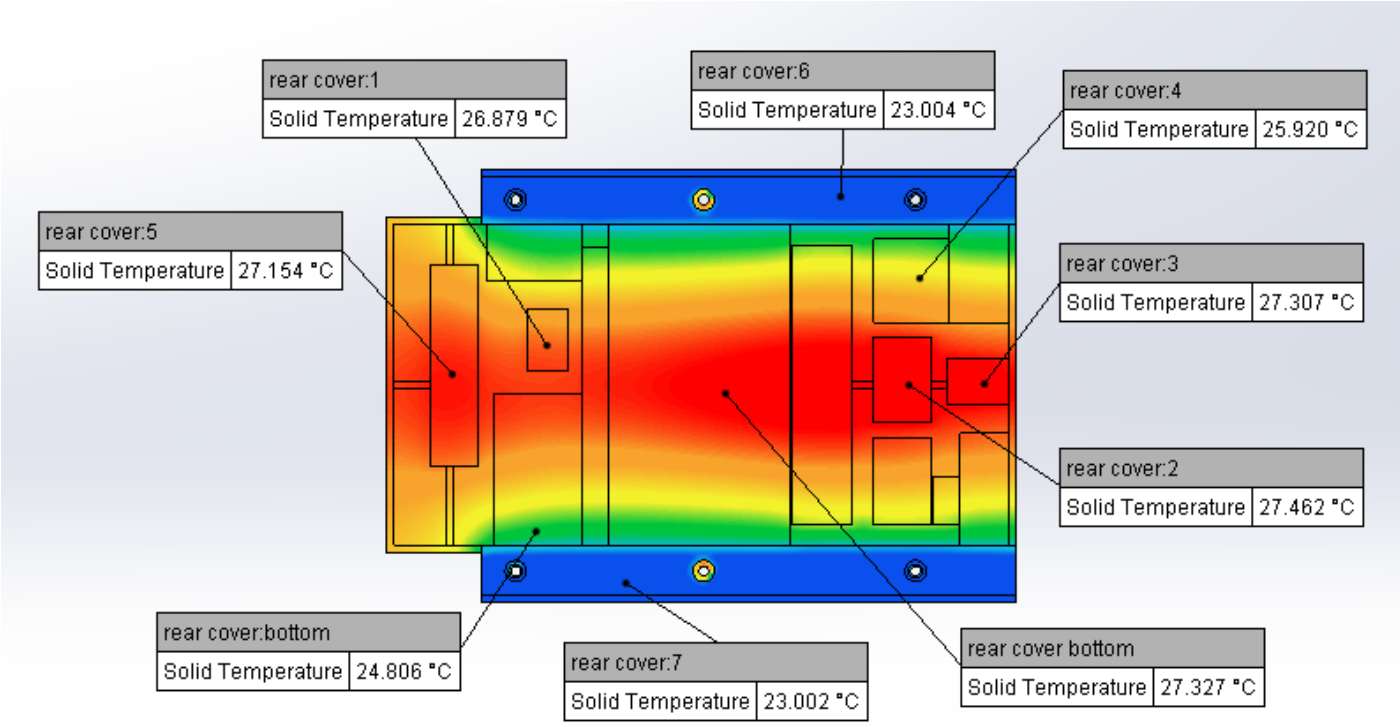
Bottom Side

Rear Cover Temperature Plot

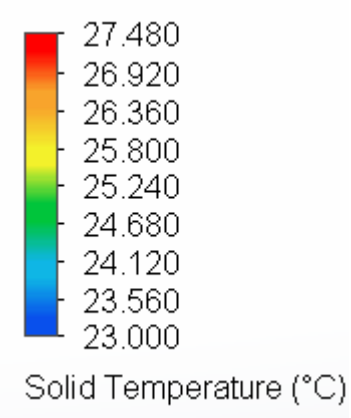
23°C , sea level



Top Side



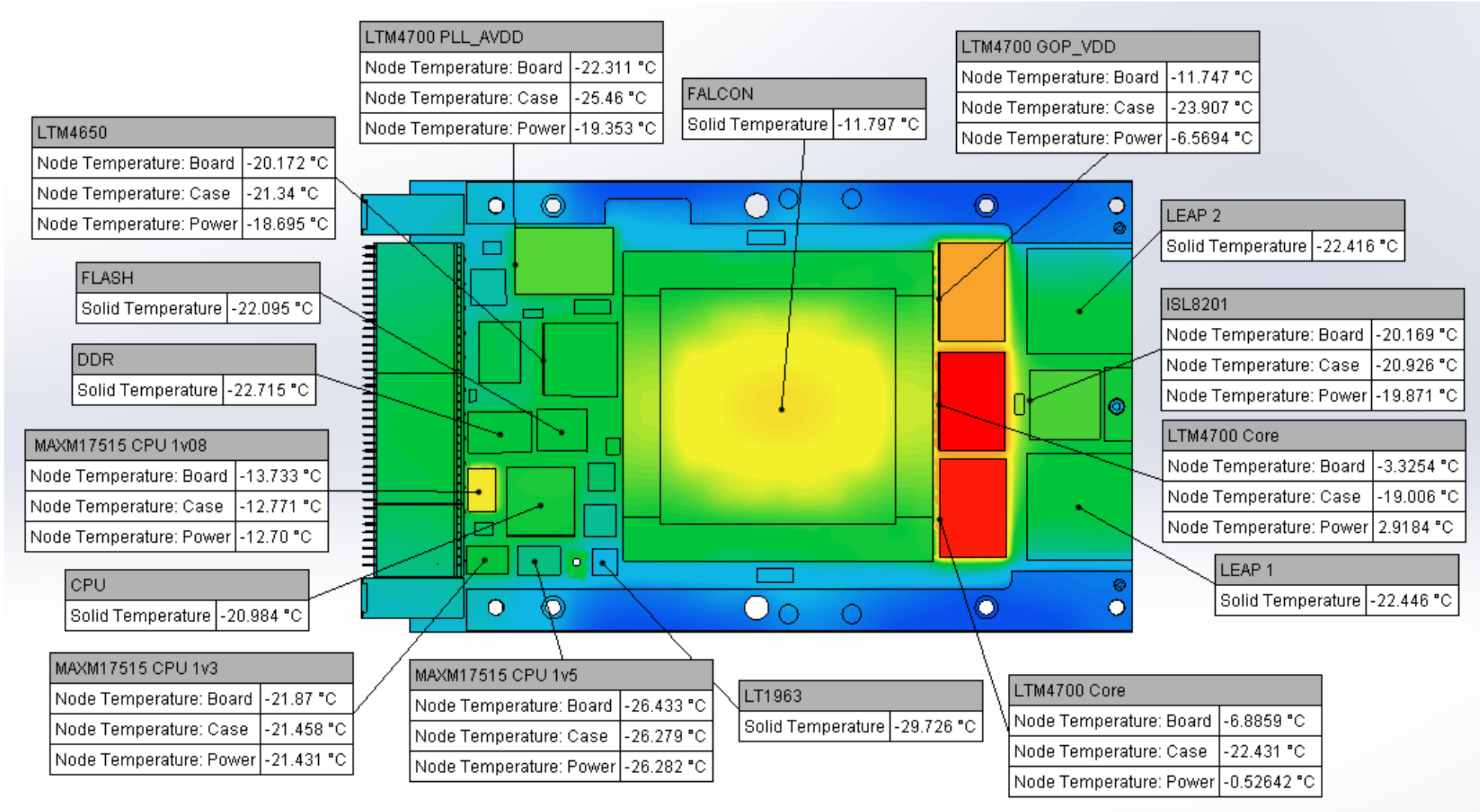
Bottom Side



-40C Ambient, Vertical, -40C Cooling Rails Copper Plate over Falcon, Al 6063 T5 Rest of Housing & Al 6063 T5 Rear Cover Worst Case Power

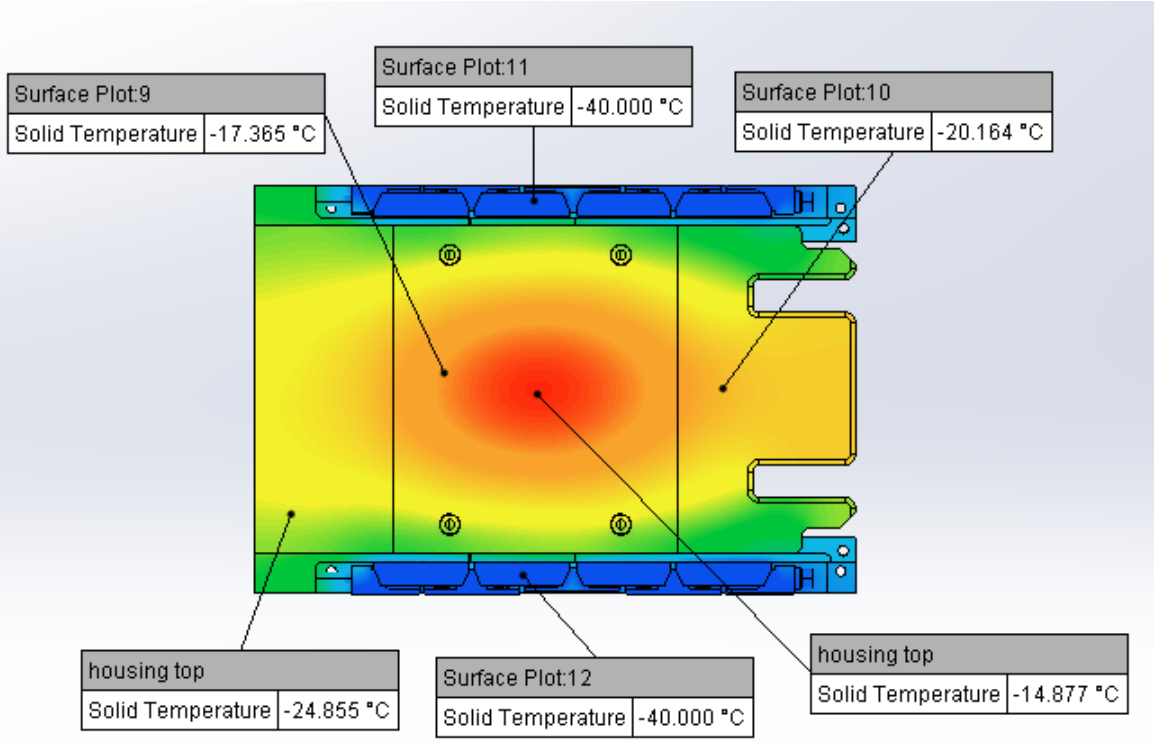
Components Temperature Plot

-40°C , sea level

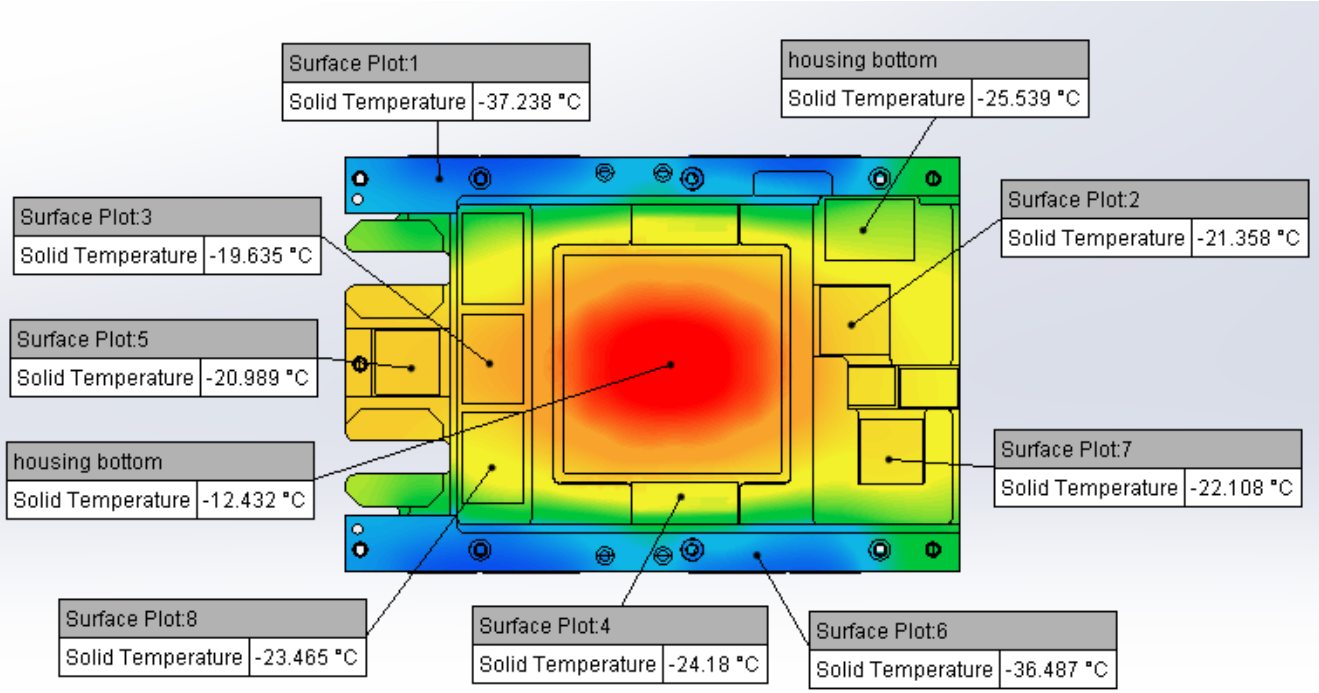


Housing Surface Temperature Plot

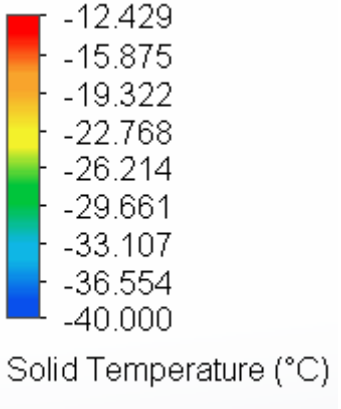
-40°C , sea level



Top Side

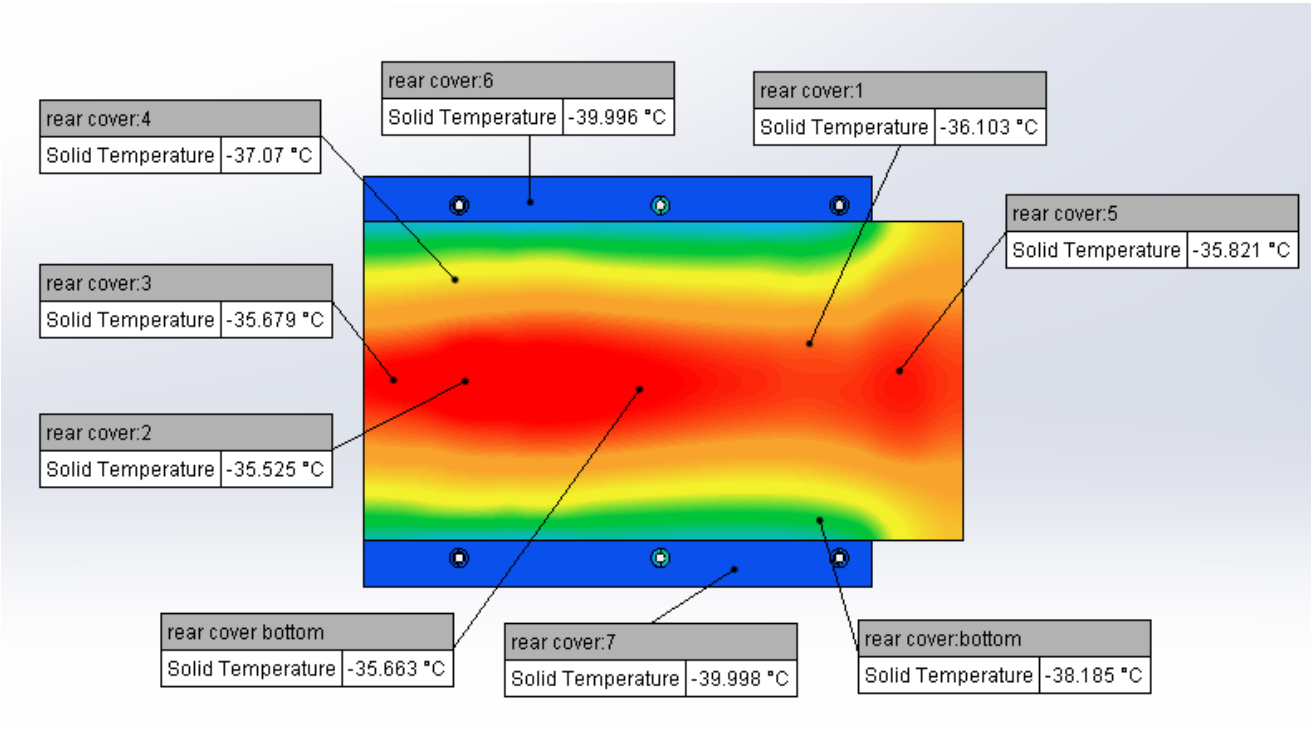


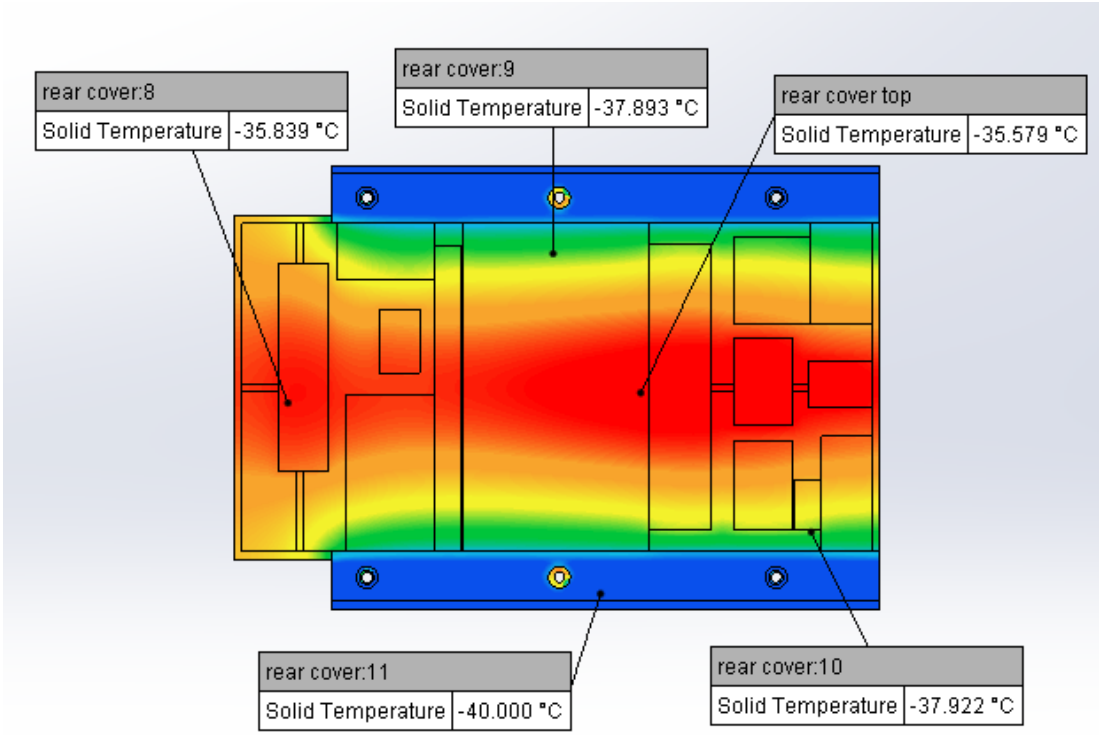
Bottom Side

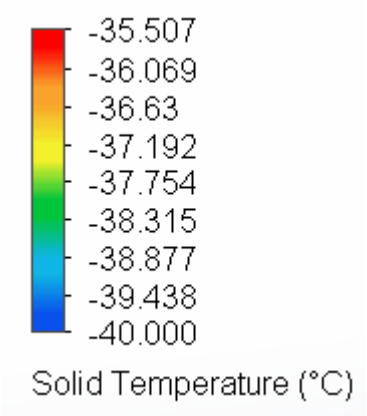


Rear Cover Temperature Plot

-40°C , sea level







Top Side

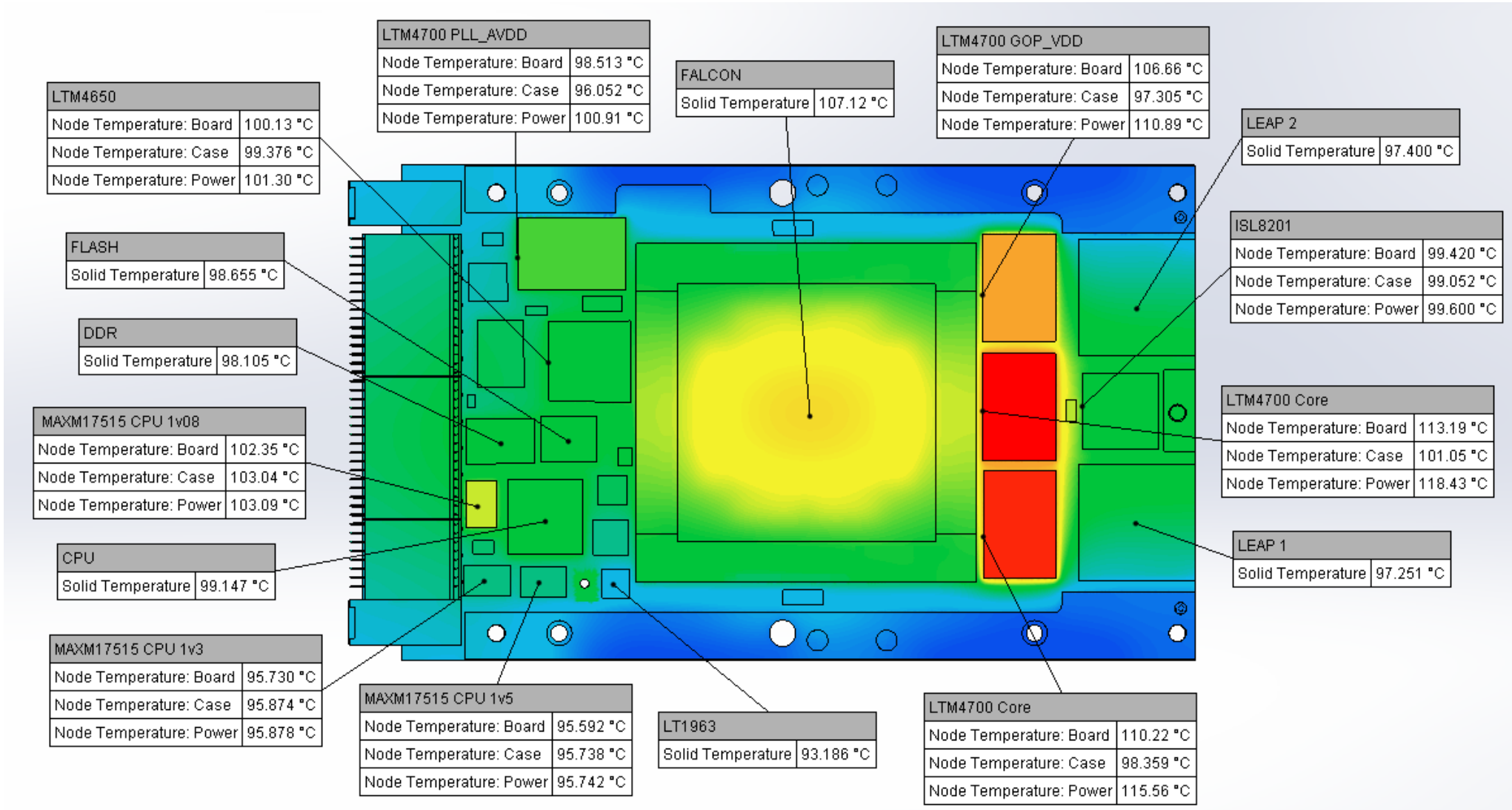
Bottom Side

Predicted Power Results

85 C Ambient, Vertical, 85C Cooling Rails Copper Plate over Falcon, Al 6063 T5 Rest of Housing & Al 6063 T5 Rear Cover Predicted Power

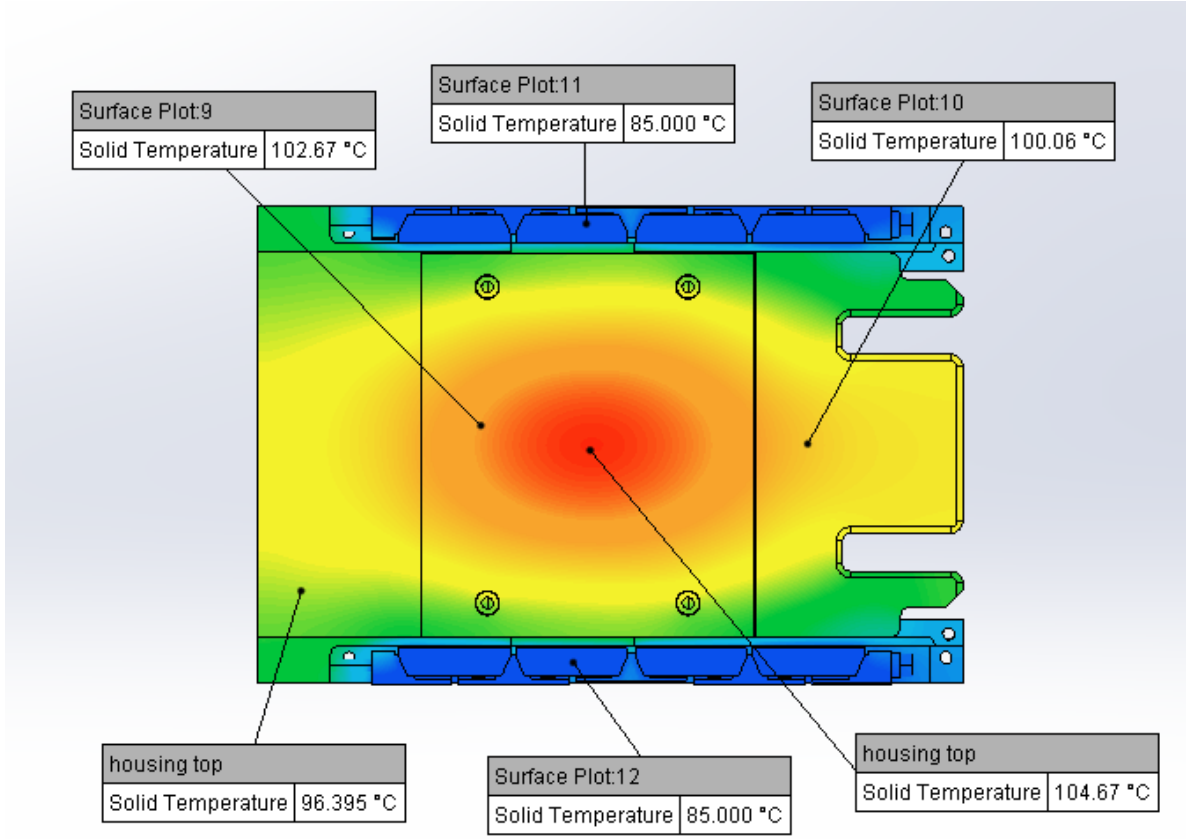
Components Temperature Plot

85°C , sea level

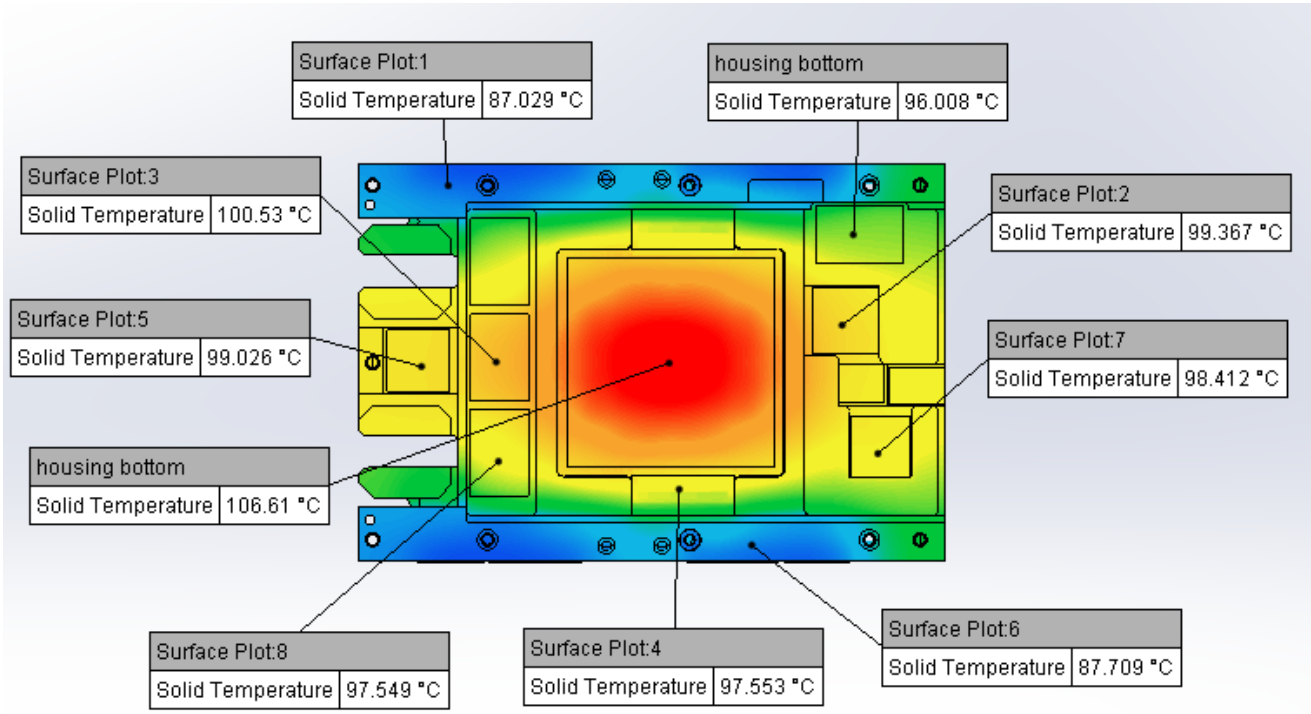


Housing Surface Temperature Plot

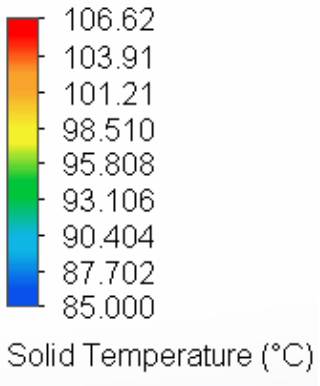
85°C , sea level



Top Side

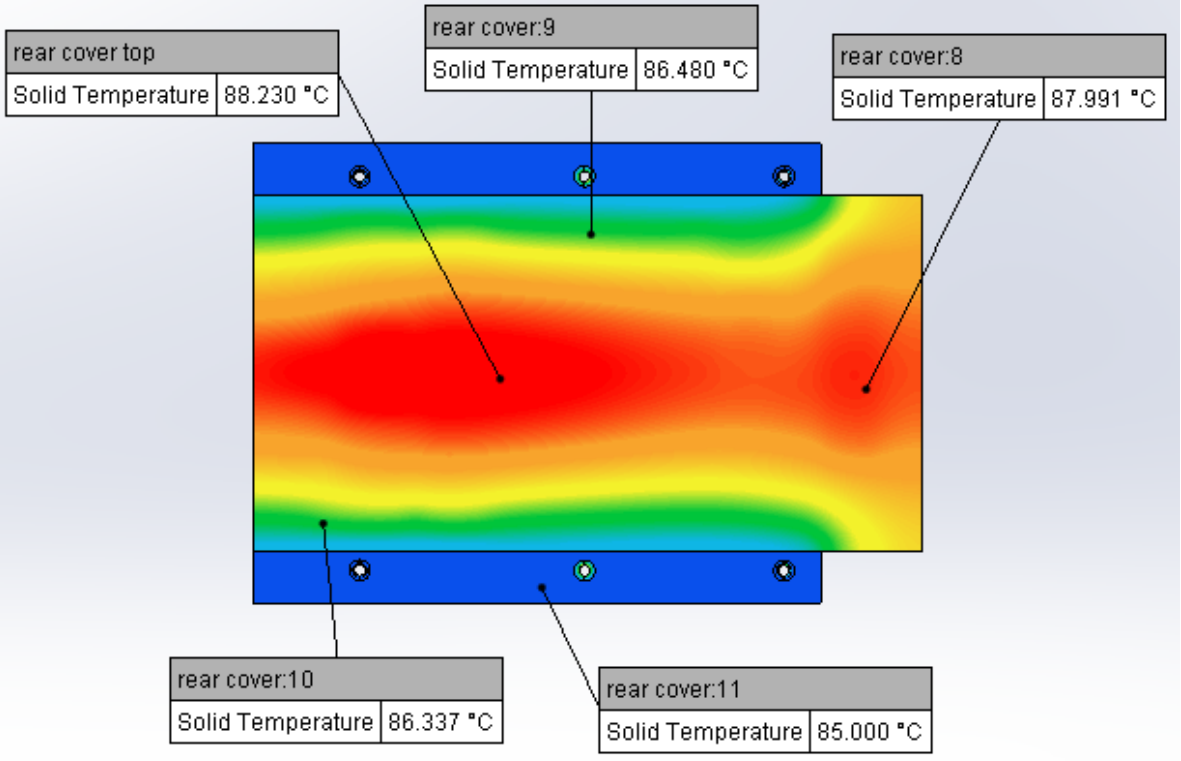


Bottom Side

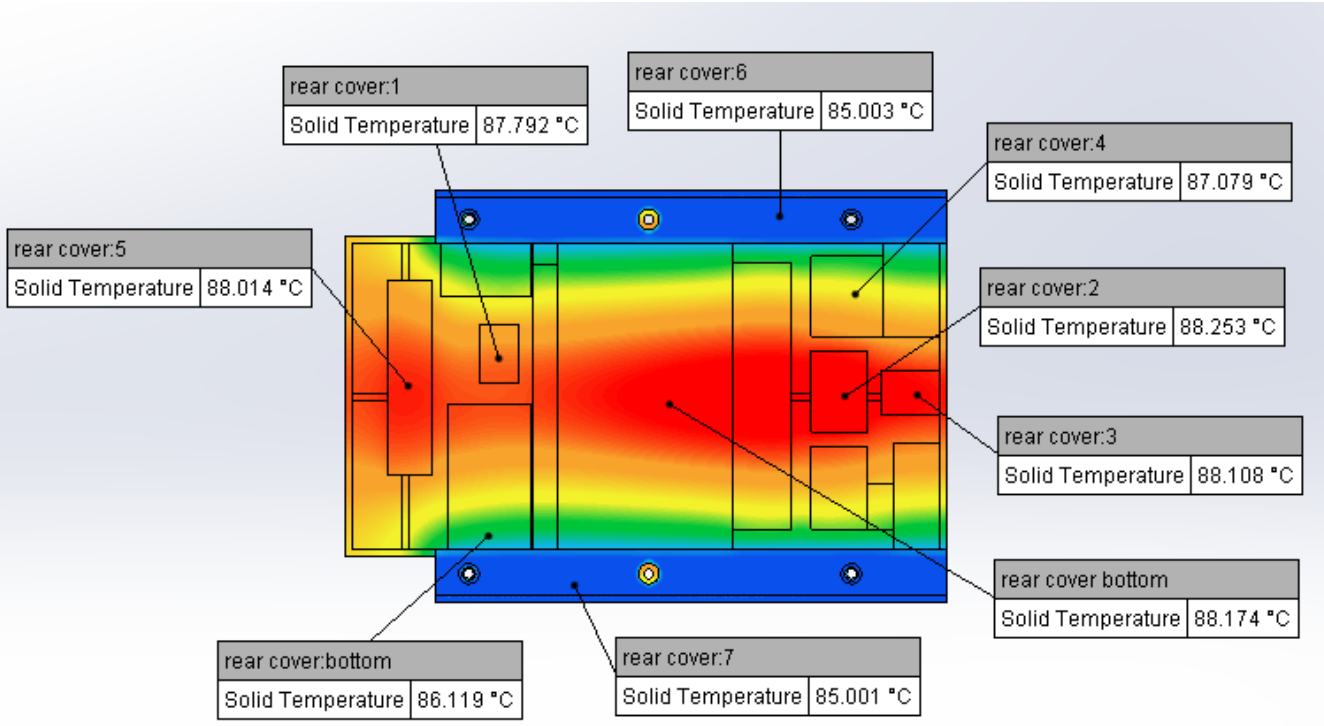


Rear Cover Temperature Plot

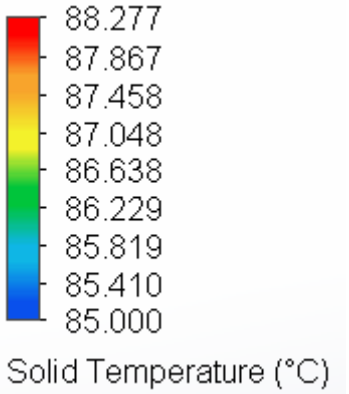
85°C , sea level



Top Side



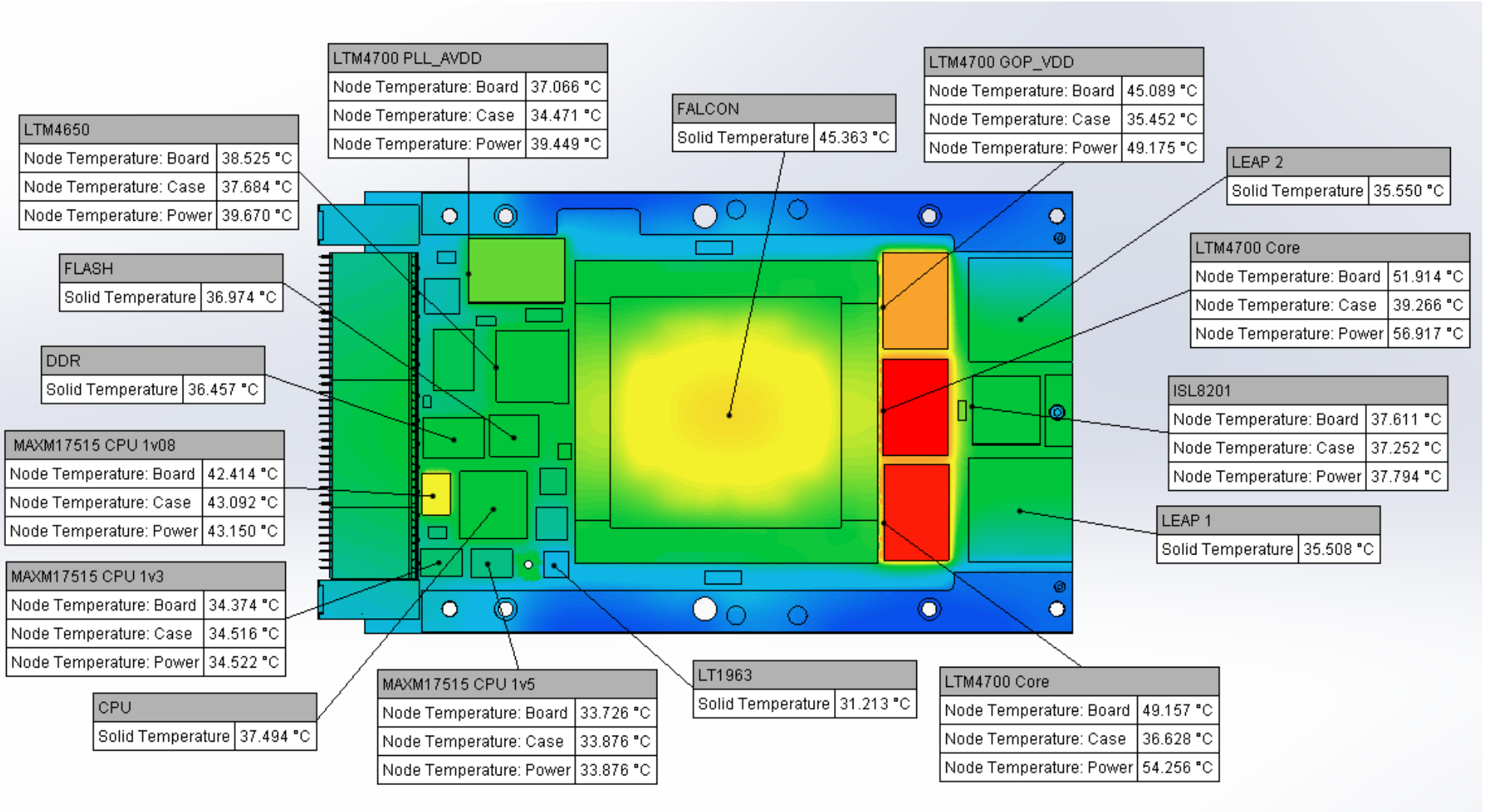
Bottom Side



23 C Ambient, Vertical, 23C Cooling Rails
Copper Plate over Falcon, Al 6063 T5
Rest of Housing & Al 6063 T5 Rear Cover
Predicted Power

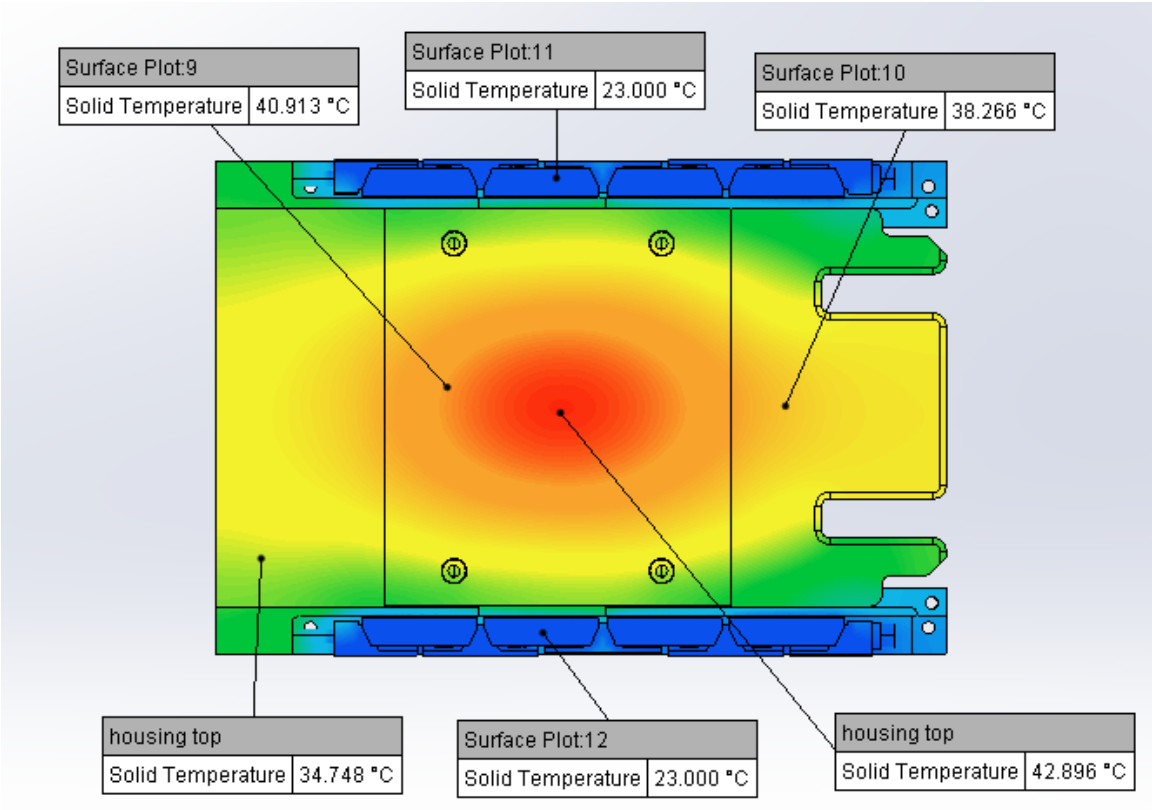
Components Temperature Plot

23°C , sea level



Housing Surface Temperature Plot

23°C , sea level



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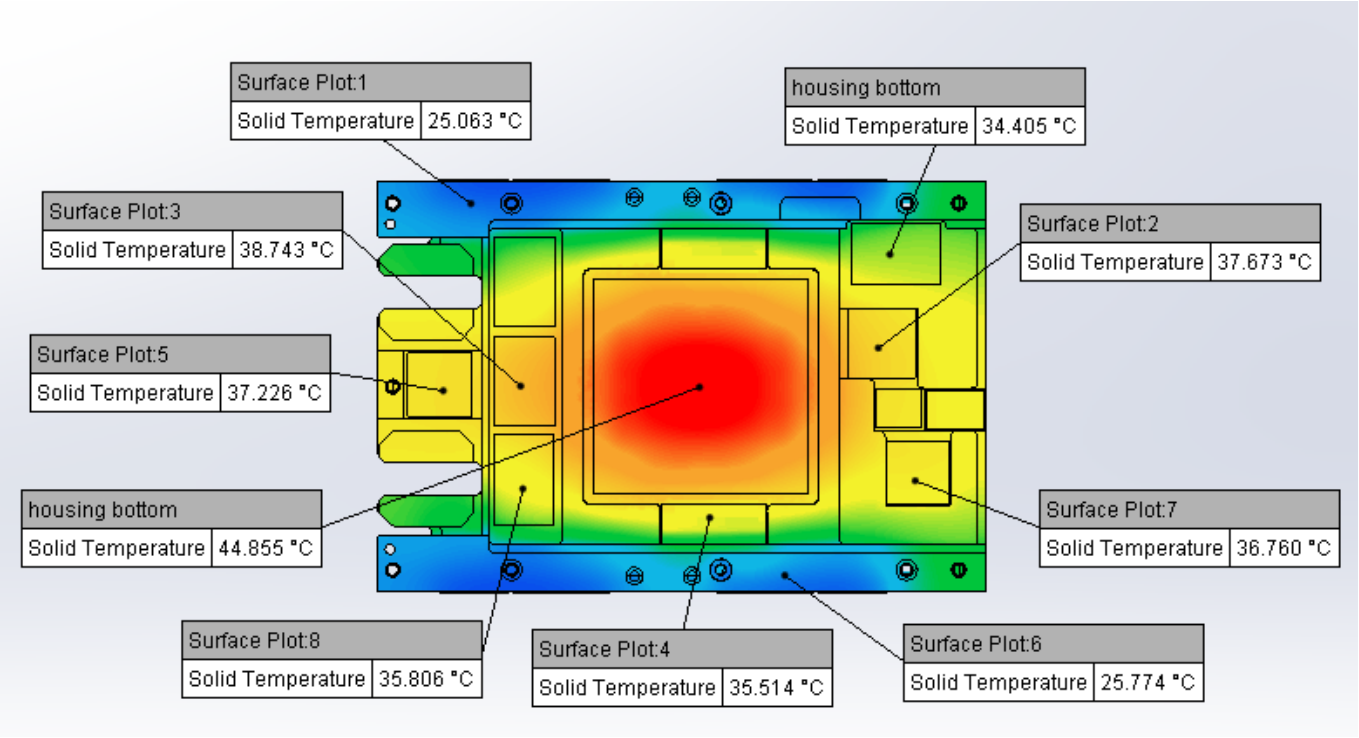
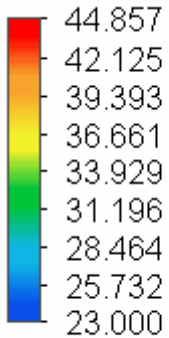
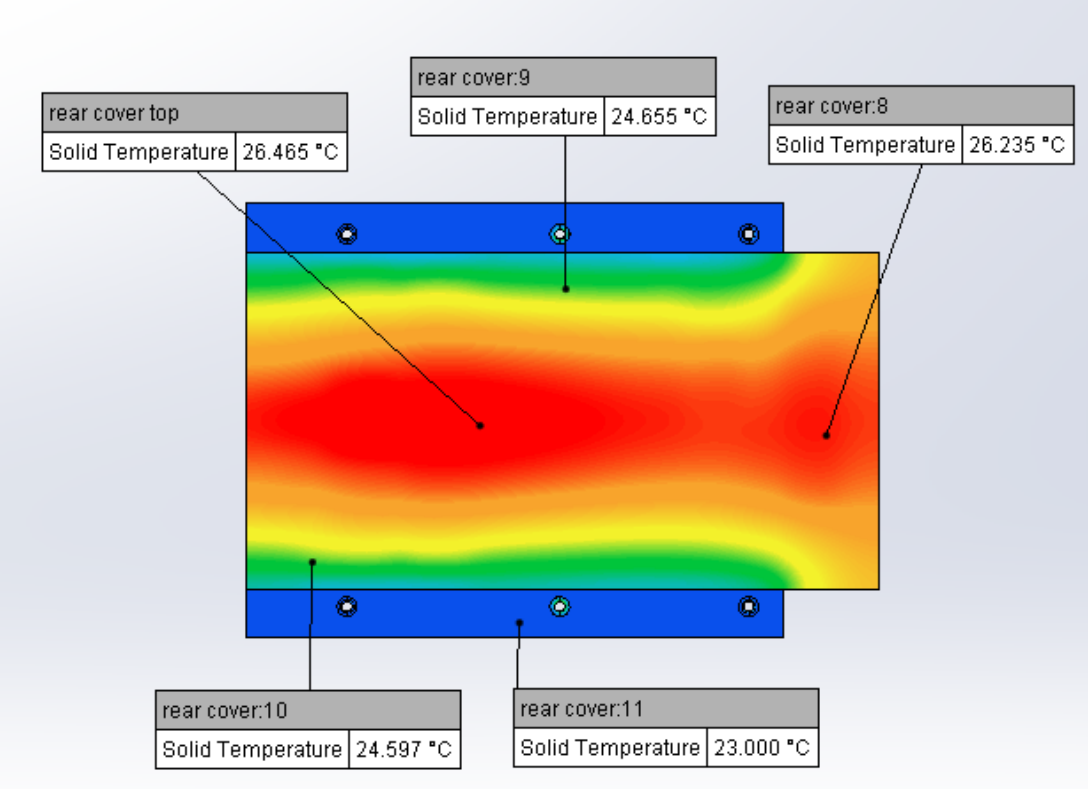


Bottom Side

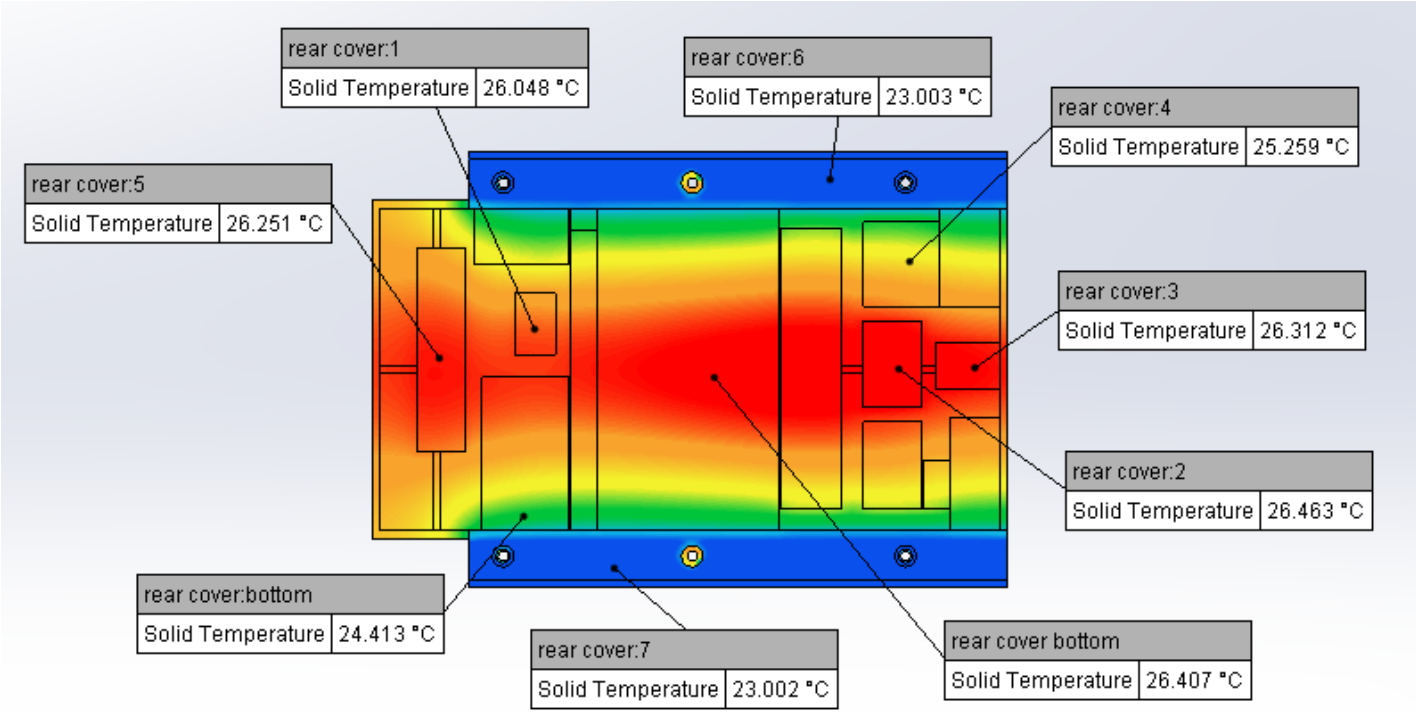


Rear Cover Temperature Plot

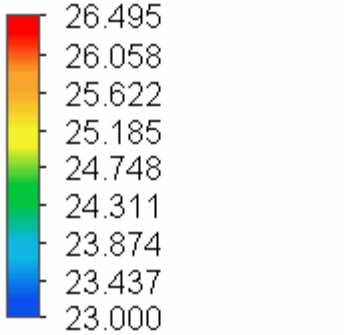
23°C , sea level



Top Side



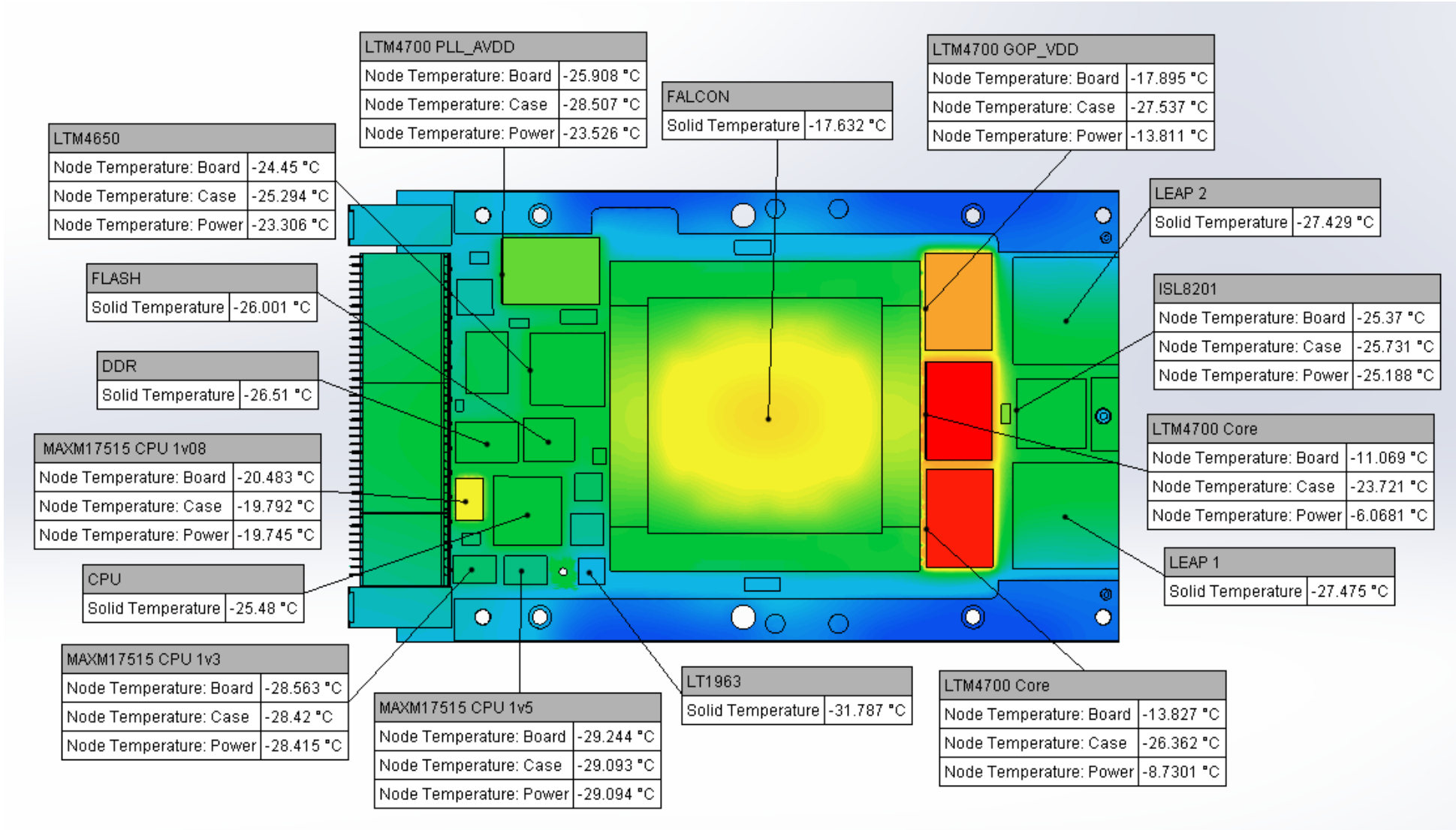
Bottom Side



-40C Ambient, Vertical, -40C Cooling Rails Copper Plate over Falcon, Al 6063 T5 Rest of Housing & Al 6063 T5 Rear Cover Predicted Power

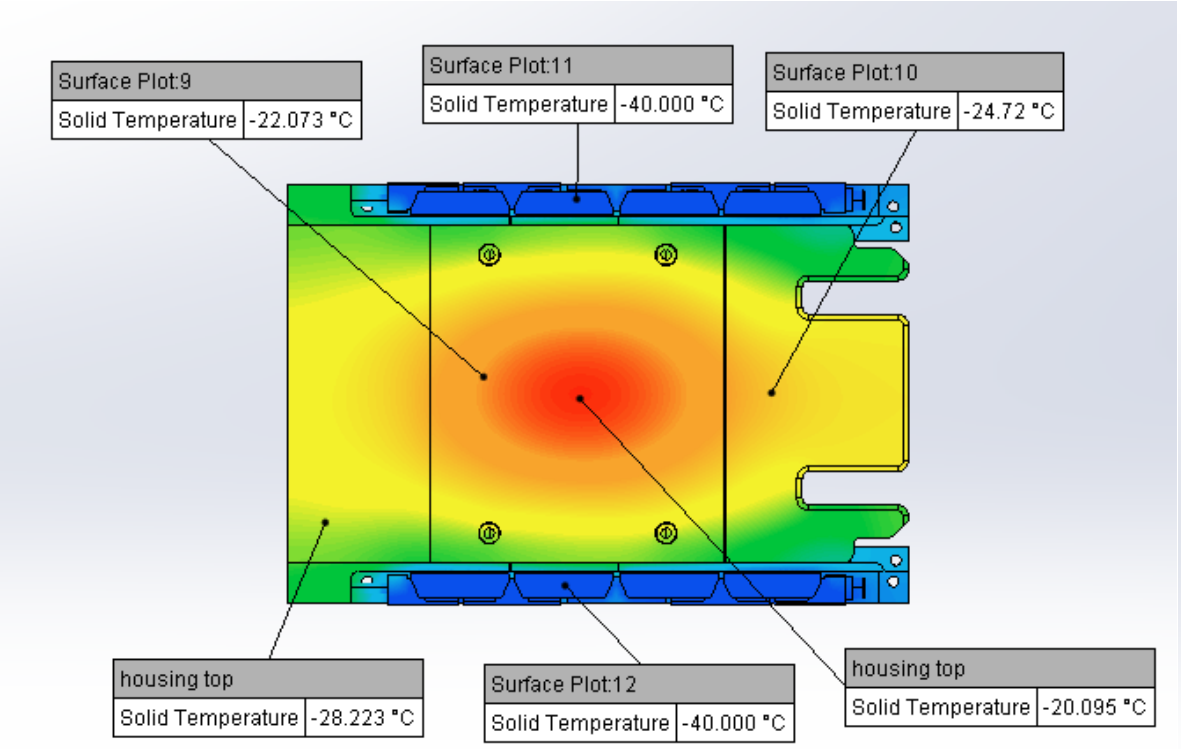
Components Temperature Plot

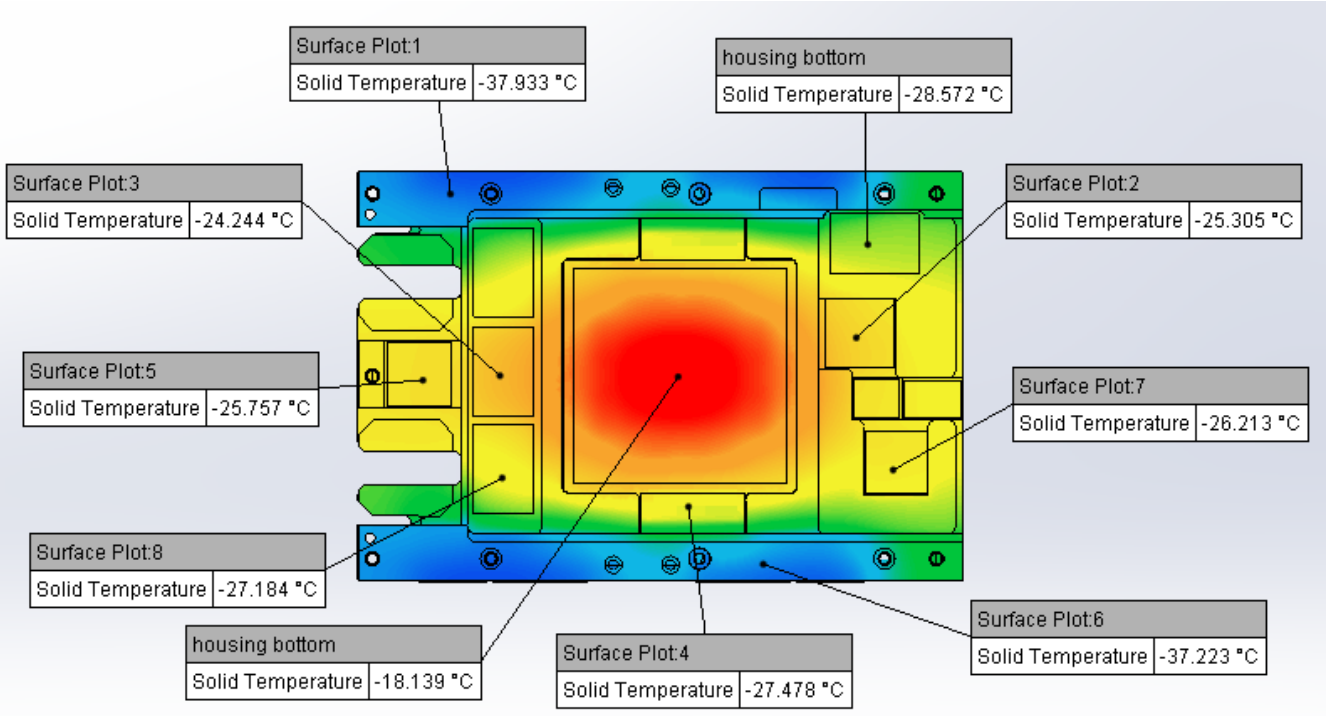
-40°C , sea level

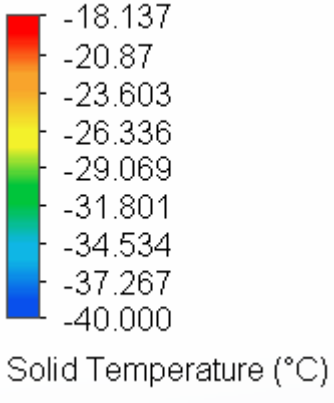


Housing Surface Temperature Plot

-40°C , sea level





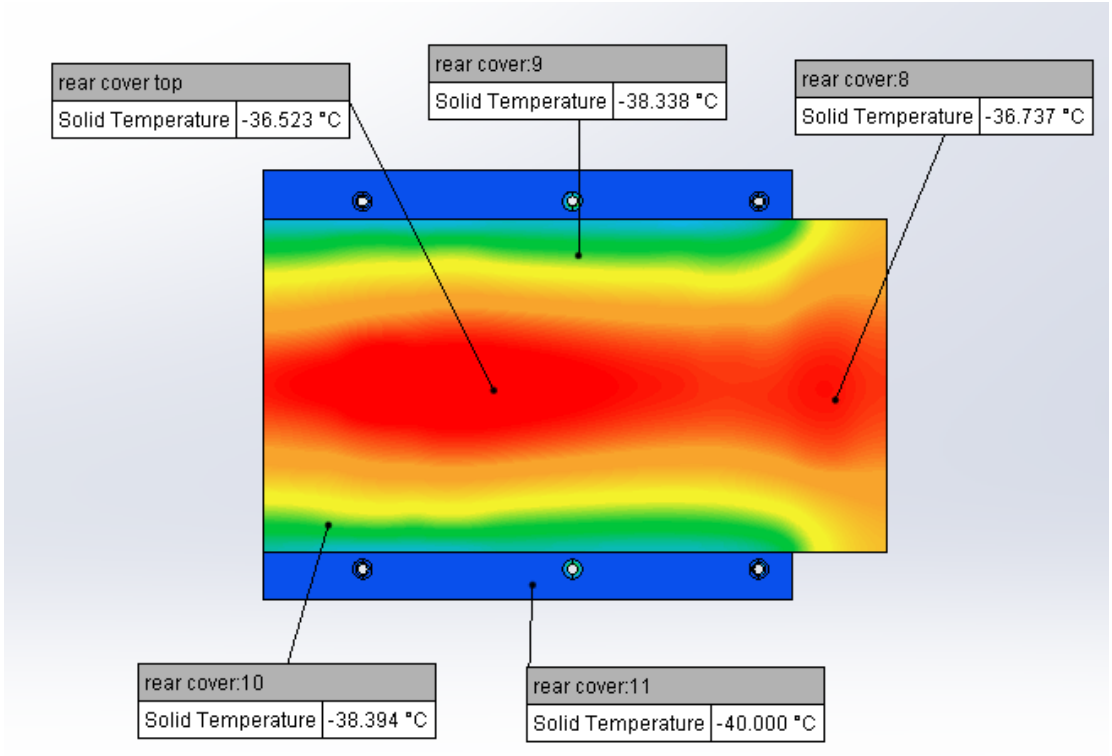


Top Side

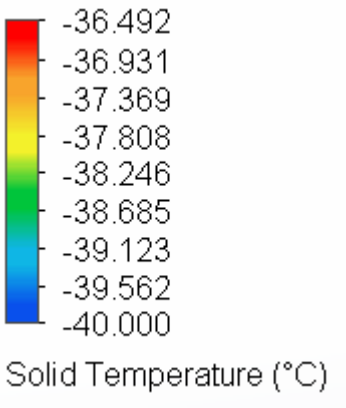
Bottom Side

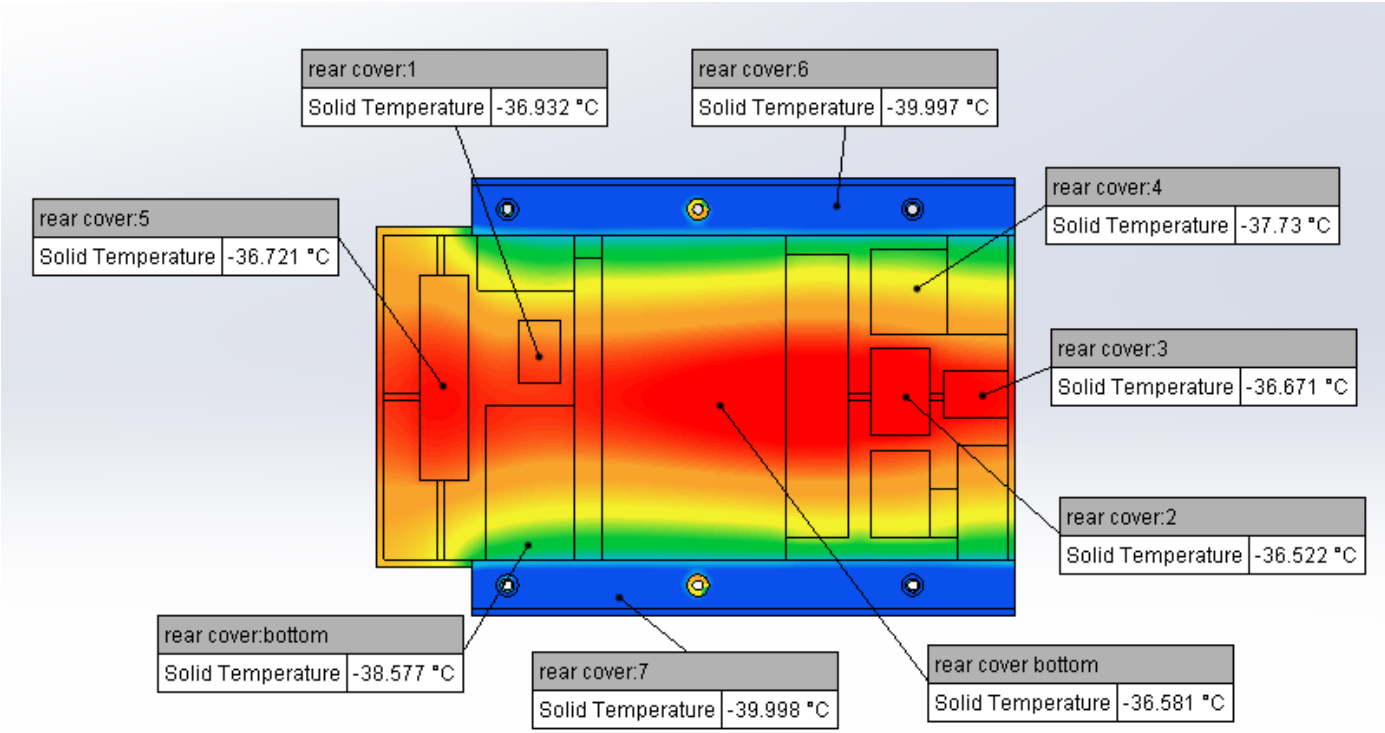
Rear Cover Temperature Plot

-40°C , sea level



Top Side





Bottom Side